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ENGINEERING AND MINING JOURNAL

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Mining Copper in Tennessee

By C. H. McNaughton

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Mineral Deposits of Porto Rico

By Bela Low

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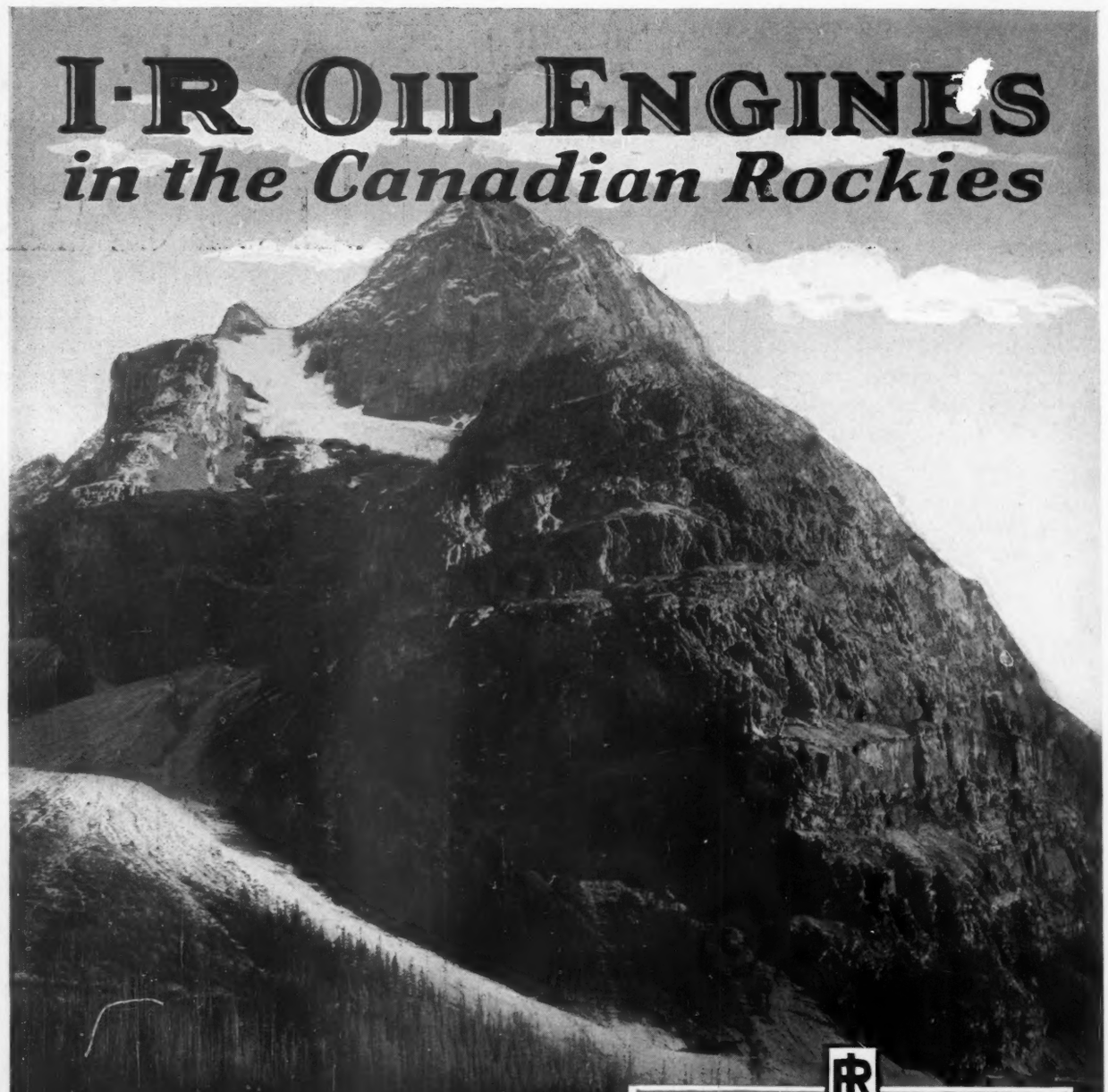
Complete Quotations on Metals, Ores, and Non-Metallic Minerals in This Issue

I-R OIL ENGINES
in the Canadian Rockies



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ENGINEERING AND MINING JOURNAL

A consolidation of "Engineering and Mining Journal" and "Mining and Scientific Press"

A. W. ALLEN, *Editor*

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New York, July 6, 1929

Features of *E.&M.J.*: XII—Industrial Progress

MODERN technique and modern equipment in the mining industry go hand in hand. One of the first requirements in the intelligent solution of a problem is a thorough knowledge of the latest equipment that may be employed. The Industrial Progress section of *E.&M.J.* was recently expanded to meet the demand from readers for complete and impartial descriptions of all the newest developments in the tools of the industry. By carefully scanning this section, week by week, one cannot help but be impressed by the ingenuity of manufacturers whose equipment has contributed so much to the prosperity that progressive mining companies have recently been enjoying.

Contents

Editorials 1
Historical Summary
New Nickel Producer Plans to Enter the Field
Encourage the Junior Members of the Staff
British Recognition of Soviet Should Help Russian Mining
Copper Industry Recovery Offers an Object Lesson
Flow of Ore-Pulp Deserves Study

Hydraulic Mining in Oregon..... 4
Illustrations

The Mineral Deposits of Porto Rico..... 5
BY BELA LOW

Phosphate Supply Adequate..... 7

Mining Copper at Ducktown, Tennessee..... 8
BY C. H. MCNAUGHTON

Leaching Manganese From the Siliceous Iron Ores of Minnesota—II.....14
BY CARL ZAPFFE

Medallion to Commemorate Anniversary of the Incandescent Lamp..... 19

Mine Shop and Plant	20	Mining News	27	Service Directory	45
Comment and Criticism	22	Market and Financial News	33	Searchlight Section	46-48
Book Reviews	23	Market Report	35	What and Where to Buy	50-52
Personal Notes	25	Metal Statistics	39		
Obituaries	25	Mining Stocks	40	Advertising Index	54

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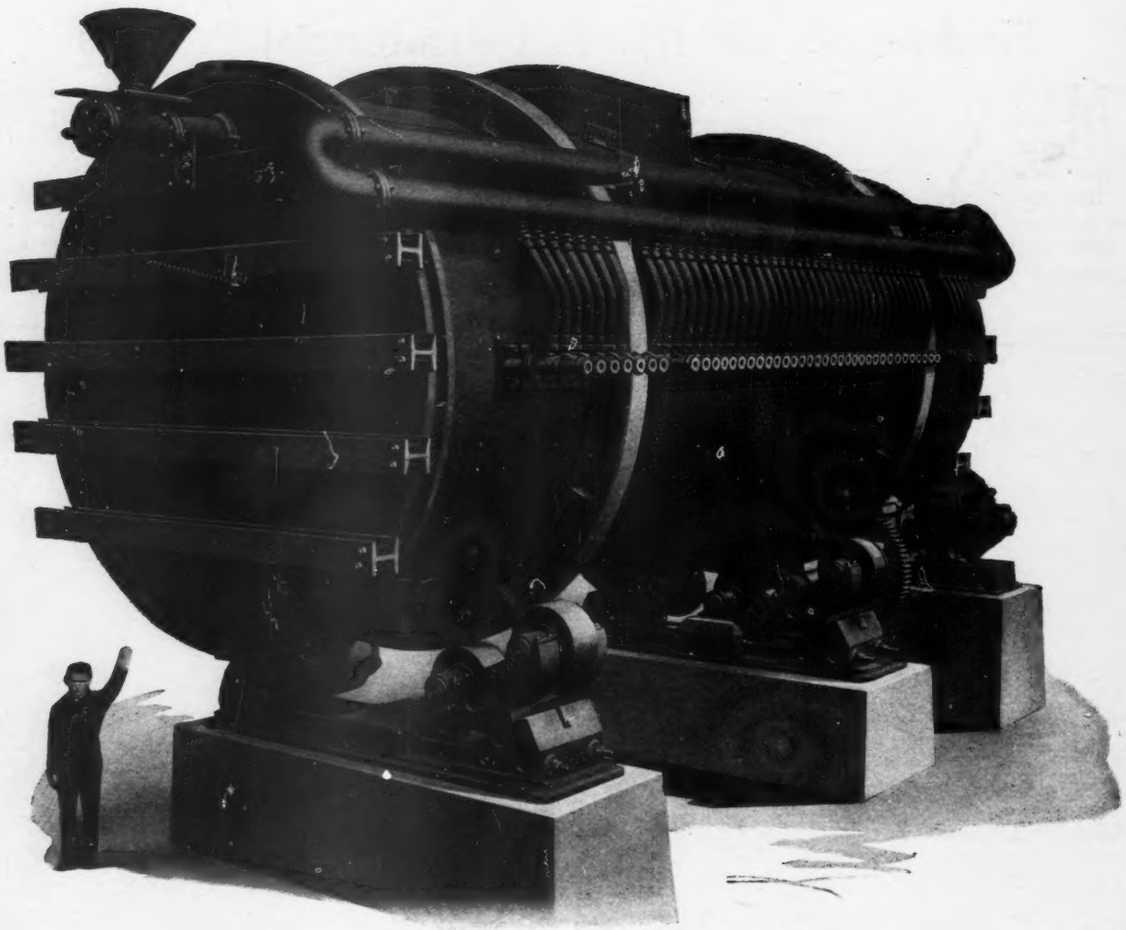

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ENGINEERING AND
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A McGraw-Hill publication, established 1866 — A. W. ALLEN, *Editor*

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Historical Summary

Engineering and Mining Journal was founded in 1866 as the *American Journal of Mining*, with George Francis Dawson as Editor. In 1869 the name was changed to *Engineering and Mining Journal.*

Publications which have been absorbed are: 1875, *Coal and Iron Record;* 1877, *The Mining Review* (Denver); 1879, *The Polytechnic Review;* 1902, *Mining and Metallurgy;* 1906, *Mining Magazine;* 1917, *Mining and Engineering World.* The successive editors have been Rossiter W. Raymond, Richard P. Rothwell, Fred Hobart, David T. Day, T. A. Rickard, W. R. Ingalls, J. E. Spurr, and A. W. Allen.

On April 1, 1922, *Engineering and Mining Journal* was consolidated with *Mining and Scientific Press* as *Engineering and Mining Journal-Press.*

The *Mining and Scientific Press* was established in 1860 as the *Scientific Press.* Three years later, "Mining" was added to the title. The editors have been Almond D. Hodges, Charles G. Yale, J. F. Halloran, T. A. Rickard (twice), and H. Foster Bain.

On July 1, 1926, the consolidated magazine reverted to its former name, *Engineering and Mining Journal.*

The staff of the *Engineering and Mining Journal* consists of A. W. Allen, editor; E. H. Robie, George J. Young, and A. H. Hubbell, associate editors; W. N. P. Reed and H. D. Keiser, assistant editors.

New Nickel Producer Plans to Enter the Field

FOLLOWING closely on the consolidation of the International and Mond nickel companies—the two leading producers of the world and the only ones of any importance—comes evidence that a new company is soon to produce from one of the numerous copper-nickel deposits in the vicinity of Sudbury, in northern Ontario, and also that occurrences of nickeliferous pyrrhotite in northern Saskatchewan are being investigated by prominent independent companies. For some time there was question as to how nickel-copper matte from an independent producer might be disposed of, but this difficulty seems to have been solved, so far as the new Falconbridge company is concerned at least, by acquisition of the rights and equipment to use the Hybinette process in Norway. Remains only the selling problem, which should not be difficult of solution, so long as the new production is not a serious thorn in the side of the International company. The New Caledonia producers, represented in this country by the United States Nickel Company, of New Brunswick, New Jersey, have been allowed to pursue the even tenor of their way for years, but they are responsible for not more than about five per cent of the world's output, and the production of other parts of the world is even more inconsequential.

The International company has no monopoly of nickel-ore deposits in the Sudbury district, and any new company that can successfully develop an orebody and market the product has a good chance, provided costs can be kept down. It must be remembered that nickel is not selling for any more than it was before the war. Stabilization, so far as the International Nickel Company has been concerned, has never meant the advancing of prices and their maintenance at high levels. This company has preferred to work for an increased production rather than an increased price. In fact, with the economies no doubt effected by merging the two old companies, and in view of the richness of the orebody under development at the Frood mine, a decline in price in the years to come may well result. Therefore, new companies must not figure too close, with profit estimates based on 35c. nickel and 18c. copper; nor can they expect to become important competitors in the world's markets from any orebody so far discovered.

The opportunity to break what is considered a monopoly, if it apparently can be done profitably, is always stimulating. But monopolies are not the ogres that so many once were, organized for the purpose of harassing their customers with high prices and the practice of a "public-be-damned" policy. Increased efficiencies gained by centralized production and control of markets are more and more being used to promote general industrial welfare. International Nickel, producing perhaps ninety per cent of the world's nickel, is an excellent example of an intelligent understanding of the value of such a policy.

Encourage the Junior Members of the Staff

ANDREW W. ROBERTSON, chairman of the Board of the Westinghouse company, recently averred that: "There is an unconscious tendency in business not only to fail to give credit to junior members of the organization . . . but actually to take it away from them. I have found," he added, "that there is an unbelievable magic in frankly tendered credit and praise."

Few mining companies publish in their annual reports the names of the operating officials who have con-

tributed to the success of the enterprise. Rarely does the head of a department give credit to a subordinate, despite the obvious fact that a zealous co-operation between all concerned has been responsible for the results.

The obligation of a company toward its employees does not end with the payment of salary, even in regard to juniors. A technical engineer, even though he be in a subordinate position, should be permitted to become articulate to his fellow engineers—through the pages of the engineering magazines or in the transactions of his professional society. Admitting the occasional need for the censorship of articles containing information in regard to company operations, no excuse can be offered for a set rule insisting that no member of the staff shall contribute to that melting pot of knowledge that has made possible the state of technical efficiency existing today. The board of directors and the general manager who can appreciate their obligations in this respect will find that much credit will reflect on them for an attitude that indicates an appreciation of the work of others, and of a desire for general advance, based on the fact that the ability of the individual makes for the efficiency of the staff as a unit.

British Recognition of Soviet Should Help Russian Mining

AS MIGHT have been expected, one of the first acts of Premier MacDonald, after assuming office, was to set machinery in motion that would lead to the official recognition of the Soviet government by Great Britain. The colonies have been informed of his intention to take this step, and belief is current that he will receive sufficient support from rival political parties in the House of Commons. The King's speech, which in reality is essentially a statement as to government program, is expected to make official reference to the end of the period of strained relations between Petrograd and Downing Street that began in 1927, following a raid on the London headquarters of the Russian Commercial Mission.

The resumption of trade and diplomatic relations between Great Britain and Russia will undoubtedly result in an adjustment of the claim made by Russo-Asiatic Consolidated, which was based on an expert valuation of properties and assets seized twelve years ago. The amount due is a large one—£56,000,000—and Mr. MacDonald must have given this pending claim due consideration before taking the initial step in the direction of closer political relations with the Soviet government.

The original mining enterprise—Anglo-Siberian—was launched nearly a quarter of a century ago. Russo-Asiatic now owns, by moral right at least, the Irtysh, Kyshtim, Russo-Canadian, and Tanalyk properties, comprising a group of non-ferrous enterprises of great magnitude. Claims and concessions cover an area of 2,500,000 acres. Twelve metal mines have been developed, with large reserves of ore. Coal properties have an outlet capacity of 400,000 tons per annum, with reserves of almost unlimited extent. The metallurgical plants belonging to the company include two copper smelters, an electrolytic copper refinery, a lead plant, a half-completed zinc plant of 24,000 tons' capacity, cyanide plants and refineries, a "powder" plant, sulphuric acid works, saw mills, railroads, steamers and barges, with the necessary auxiliary plant and housing equipment.

Pending the settlement of the claims of Russo-Asiatic, a new company has been formed—Mining Trust—which has the right, if and when the above-mentioned properties are returned, to finance a program of rehabilitation and expansion in Russia. In the meantime, Mining Trust has extended the scope of its interests, and has wisely utilized the technical skill of the parent organization, by the acquisition of control or of controlling interests in mining work in Australia (Mount Isa), in France, New Guinea, and Northern Rhodesia.

The wisdom of such diversification of interests is apparent. It will bring together, in a manner otherwise unattainable, the elements of group success that are now restricted by geographic boundaries. It will help in the internationalization of the mining industry and the freer exchange of technical knowledge. It will aid in the removal of friction because of the closer contact of leaders in mining and metallurgical technique, in management and finance. The MacDonald government has a heavy responsibility in seeing that recognition of the Soviet government by Great Britain is followed by fair treatment of Russo-Asiatic, but *Engineering and Mining Journal* has faith in the outcome.

Copper Industry Recovery Offers an Object Lesson

SPEAKING at Asheville, N. C., recently, Mr. George A. Sloan, secretary of the Cotton-Textile Institute, formerly secretary of the Copper and Brass Research Association, reviewed progress in the copper industry in readjusting itself to post-war economic conditions. Three years after the armistice was signed, he said, the copper industry, then on the verge of disaster, took stock of itself. Over 1,125 million pounds of copper was available, 600 million pounds of which was surplus war stocks resulting from the development of mines and plants during 1914-18, directly and indirectly for military purposes. The industry was therefore confronted with the task of finding peace-time commercial outlets—without disrupting the producing, distributing, and consuming industries—for an over-supply approximating one year's production from North and South America.

An initial move was to compile and to distribute information as to production, stocks, and shipments, and to utilize to the full the statistics on consumption of copper by industries being compiled by the American Bureau of Metal Statistics, formed in 1919. The coordination of supply to demand in recent years has been based on the intelligent use of such statistics on the part of independent producers. The second step was the formation of the Copper and Brass Research Association in 1921, to promote domestic markets, dealer-help cooperation, and national advertising; to make surveys of present and potential markets for copper and brass products, and to present its researches in a form that

would enable the mining and fabricating companies, respectively, to capitalize on the information in their sales promotion efforts. In co-operation with dealers in copper and brass products, the Association has been a real educational force in drawing attention to the value of copper and brass, to the trade and to the consuming public. As illustrative of the value of such efforts it is sufficient to mention that the domestic consumption of copper rose from 920 million pounds in 1921 to 2,000 million pounds in 1928. This represents an increase of more than 100 per cent. Every year during this period a substantial gain occurred in the domestic consumption of copper.

Mr. Sloan cites proof of the value of advertising and other sales promotional efforts by stating that, previous to 1921, the use of brass pipe was considered a luxury, and its adoption for household plumbing fixtures was almost negligible. Using this specific market as one that could be economically and profitably developed, the Association was instrumental in increasing the copper consumption in brass pipe from 16 million pounds in 1922 to 75 million pounds in 1928—a gain of nearly 370 per cent. In this instance, also, the increases were substantial in each year of the period.

As a third accomplishment, Mr. Sloan reminded his hearers, extensive follow-up sales efforts and national advertising appeals were organized by large fabricators of copper and brass, with the result that the average home builder is now familiar with such names as Anaconda, American Brass, Chase, Republic, Bridgeport, and others. These fabricating companies supplemented the national advertising of the Association by individual sales promotional budgets, and some of them are now to be found among the largest advertisers in the United States.

Mr. Sloan also pointed out that the copper industry has been alert in following the general economic trend in favor of consolidation. Important mergers, vertical and horizontal, have been negotiated to achieve economy in production and distribution. He also cited a general re-alignment of the industry's sales policies and methods, and the changes that have been made in distributing fabricated products; the extension of advertising and publicity efforts to foreign countries; and the formation of the Copper Institute—to study fundamental economic questions of production and distribution, and to encourage the adoption of fair trade practices. Attention may also be drawn to the progress made by North American mining companies in lowering production costs, mainly by the adoption of new and improved processes and by large-scale output. Although costs have been reduced, the wages paid by the principal mining companies in the United States have increased about 20 per cent since 1921.

It is necessary to explain, as Mr. Sloan points out, that the copper industry did not recover as the result of adopting any short-cut to success, but by reason of the collection and dissemination of statistics; by careful analysis of these statistics by the individual producer, and the readjustment of production to demand. It moved a step nearer its goal in organizing for national sales promotional work through the Copper and Brass Research Association, the mining companies (producers), and the fabricating companies (distributors), forming the equivalent to one trade association to solve problems of concern to each branch of the industry. Further progress was made by concentrating foreign sales through one export body. Of equal importance was the formation of the Copper Institute, to study fundamental economics relating to production and distribution.

Behind all these contributing factors, one is reminded, was the inspiration and leadership of a few men, including Mr. Cornelius Kelley, of Anaconda; Mr. Walter Douglas, of Phelps Dodge; Mr. R. L. Agassiz, of Calumet & Hecla; Mr. Stephen Birch, of Kennecott, and Mr. Joseph Clendenin, of the Guggenheim group, whose individual business statesmanship may be discerned in every constructive effort undertaken and carried to success since the war.

Engineering and Mining Journal agrees with Mr. Sloan that a combination of these helpful influences, rather than any one single factor, plus the accumulation of common sense, has brought copper out of the doldrums. The change has been one from imagined independence to a recognition of the advantages of interdependence and co-operation. The steps taken have been open and above-board. Other industries may benefit if they study the recent history of copper in the United States. Moreover, the foreign producer of the red metal is under considerable obligation to the American producers and fabricators for righting the boat, putting it on an even keel, and steering the craft in the direction of a healthy and sound economic success.

Flow of Ore-pulp Deserves Study

A PRESS announcement was made recently that a new scientific organization had been formed, to be known as the Society of Rheology. The dictionary contains no such word, but the account explains that rheology deals with the study of flow, which is a large subject for research, capable of unexpected revelations.

More substances will flow than is generally realized. We witnessed recently a test to demonstrate the passage of a projectile at high velocity into a cold steel plate. The result proved conclusively that the steel had flowed, without appreciable rise in temperature, away from the projectile as the latter entered the steel; and had flowed back, as far as possible, before the projectile had passed through the plate, leaving it wedged with tremendous force.

A study of rheology will deflect attention to the fact that matter is molecular and not uniform, and that particles of the densest materials are not averse to temporary or permanent rearrangement under new conditions. But the science of rheology is a study that will appeal to the metallurgist and the millman mainly because of the problems of pulp flow; for countless errors have been made in mill design in a failure to appreciate what factors are responsible for accumulation, stoppage, and chaos. The grade of launders has been based mostly on experience and empirical result. In consequence, the inclination chosen is sometimes inadequate or in excess of requirements. Now that the science of flow has been given a name, opportunity offers for the collection of data to explain the idiosyncracies of a pulp of sand or slime, or of both, that refuses to act reasonably.

Hydraulic Mining in Oregon

In the oval—Right-of-way of the "Big" cut on the Llano De Oro placers, Oregon, after the use of powder and ready for hydraulic-giant operation.

At the left—The "Big" cut on the Llano De Oro placers leading to the tunnel sluices 2,000 ft. in length through the mountain.

New pit mining site on the Llano De Oro placers, recently connected with new gravity sluice system. Hydraulic elevator and open cut for sluice at the right in the background.

The Mineral Deposits of Porto Rico

By Bela Low
Engineer of Mines, New York, N. Y.

PORTO RICO, which was ceded to the United States at the close of the Spanish-American War, is the farthest east and south of the Greater Antilles. The climate is tropical, but as the island is situated within the trade-wind belt, the temperature is always mild and agreeable. The scenery is superb. If this beautiful island is not frequented by as many American tourists as Cuba, the Volstead law is probably more the reason for this than the fact that Porto Rico is at greater distance from the United States.

The author

The island is about 90 miles long and 40 miles wide. With a population of about 1,500,000, or approximately 400 per square mile, it is one of the most densely populated areas in the world. Means of travel are excellent, as the island is traversed by a network of good automobile roads. This fact indicates the danger in making prophecies; for in an article published about 20 years ago in *Engineering and Mining Journal* the prediction that "Porto Rico, with its diversified surface, is destined always to be the land of the bull cart" was made. Economically, the island is an example of lack of self-sufficiency, as almost all articles of consumption are imported and most products are exported. These products are exclusively those of tropical agriculture and comprise sugar, as the most important, then tobacco, coffee, and fruits, such as grapefruit, oranges, and pineapples. No manufacturing industry of importance has been established on the island.

At various times attempts have been made to explore the mineral deposits of Porto Rico. I recently spent six weeks inspecting almost all the metallic deposits of the island. These are situated in the large rugged central area, which consists of cretaceous sedimentaries, mainly tuffs, into which various igneous rocks have intruded. Four copper and four iron properties, and one gold, one lead, and one manganese property, were visited. The manganese property, which is owned by the Porto Rico Ore Company, is the only producer of the group. It is situated about three miles from Juana Diaz. The orebodies consist of psilomelane and pyrolusite and are irregularly shaped small lenses in crystalline limestone that occur near the surface. The ore, which is a dioxide suitable for battery purposes, is shipped to Cleveland. Production is about 50 tons weekly. Mining methods are crude; the ore is carried by peons to a bin, whence it is transported by cableway to a mill equipped with two jigs. From there, the washed ore is transported in wheelbarrows to the crusher, where it is crushed to various degrees of fineness, according to buyers' requirements.

At Pasto, about three miles southwest of Morovis, work was done at various times on a copper property formerly controlled by the Concepcion Mining Company, but now owned by Mrs. Marie Schulte, of Newark, N. J. Ore here occurs in a fractured zone in an intrusive andesite porphyry. Mineralization, consisting of malachite, azurite, and a little chalcocite, is very spotty, most of the workings being almost barren. In a few places the vein averages about 3 per cent copper, traces of gold, and about 1 oz. of silver. About 60 tons of selected high-grade ore has been shipped from the property to smelting plants in New Jersey.

A copper prospect is situated about two miles from Aguada. The country rock is a volcanic flow, consisting of an augite andesite of amygdaloidal structure. Cavities are frequently filled with calcite, though some are empty. The mineralized area is a crushed zone in which the amygdules along some fissures have been filled with native copper and malachite, the latter being the oxidation product of the former. These veinlets are never more than a few inches wide. Exploration work, consisting of a few pits and trenches, was undertaken by a local syndicate, but was soon discontinued. Mineral rights belong to the owners of the various farms in the section.

Near San German, veins occur in a decomposed andesite porphyry. Mineralization here consists chiefly of malachite, carrying some gold and silver, but is very irregular. The best showing is in a tunnel, in which the vein averages 3¼ per cent copper over a 3-ft. width and for a length of 30 ft. One tunnel has produced about five tons of good chalcocite from a vein which is about 18 in. wide. Some other short tunnels are completely barren. In 1918, George Trautman incorporated the La Plata Mining Company, and shipped about 200 tons of selected ore from the property. A dilapidated mill containing three stamps and a Wilfley table stands on the tract. The mill was erected prematurely and was unsuitable for the treatment of the ore. After the enterprise failed, the property was bought at public auction by the present owner, Sr. Rafael Torres, of Ponce.

Near Naguabo is a copper prospect which, according to reports, was worked from 1866 to 1868. It is said that the ore was smelted and the copper shipped to Spain. This property proved inaccessible. The country rock in a ravine below the cliff where the deposit is located consists of tuffs and quartzites. Considerable float of crystalline limestone and some of rather pure malachite can be found in the ravine. No description

Early means of transport are found off the main highways

of this property can be found. In the twentieth annual report of the U. S. Geological Survey, H. B. C. Nitze describes another prospect in the vicinity, the location of which is now unknown. He states that the Santa Theresa claim, which is the one referred to here as having been worked by the Spaniards, proved inaccessible. Prof. H. A. Meyerhoff, of Smith College, who made a geological study of the section in 1926, was also unable to reach this property. Some of the float ore observed in the ravine indicates a better grade of copper than at any other prospect on the island. The property is within the boundaries of the United States (Luquillo) Forest Reserve, but, contrary to the laws applying to the public domain within the United States, is not open to location.

Near Mayaguez is a deposite of limonite, appearing as a brownish reddish soil that overlies the top of the mesa. It is underlain by serpentine, and is probably a residual deposit, presumably geologically identical with the iron deposits in northeastern Cuba. One analysis showed 57.69 per cent ferric oxide, 0.85 per cent ferrous oxide, 1 per cent nickel oxide, and 1.57 per cent chromium oxide. Part of the land is owned by Sr. Andres Rodriguez, of Mayaguez, and part is within the boundaries of the United States and the Porto Rico Forest Reserves.

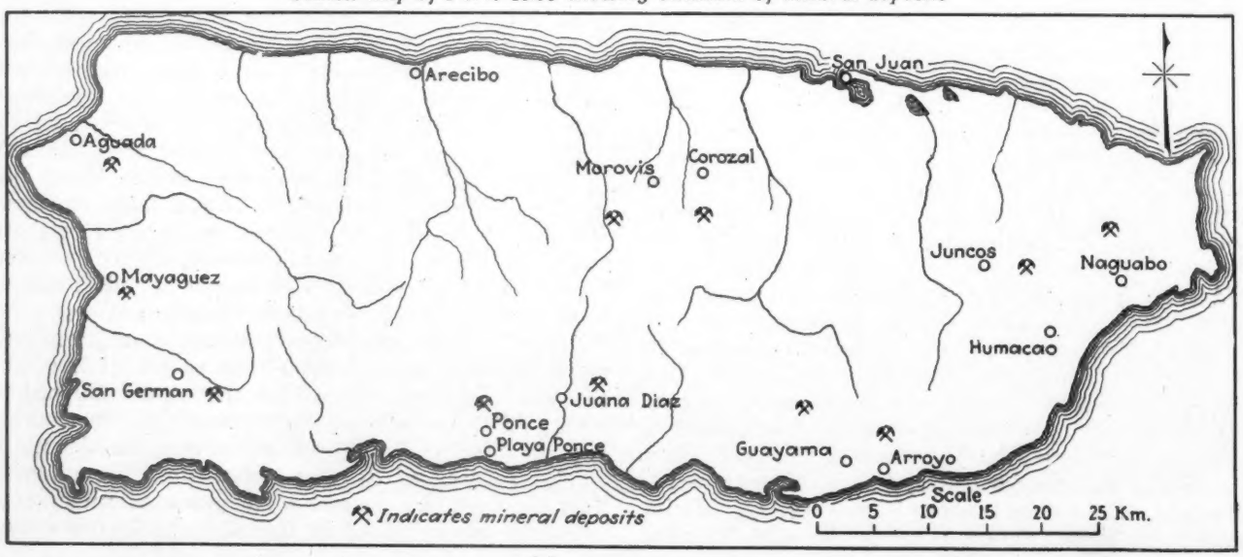
Near Ponce is a deposit of magnetite, occurring near a contact of limestone and a quartz diorite; the magnetite is said to contain 60 to 70 per cent iron. Only a small amount of work was done at the property, and most of this has caved. Overburden makes it impossible to determine the probable size of the deposit, but, as the accessible tunnels show ore only at intervals, indications are that the deposit is small and irregular. The property is owned by Sr. Thomas Blasini, of Ponce. In 1923, two Americans attempted to work the property, chartered a steamer, and began to haul ore. The attempt was soon given up and the ore left on the banks of the river below the deposit.

Another iron deposit geologically similar in type is situated near Arroyo. The little exploration work that had been done there is completely obliterated. No ore could be observed in place, but there was a fair amount of float ore. Part of the land is owned by Nido & Company, of Arroyo, and part by the Lafayette Sugar "Central," a French concern.

The best known iron ore deposit of Porto Rico, owing to its having been repeatedly described in literature, is that near Juncos. Considerable work has been done at the property, most of it about 25 years ago by the Spanish American Iron Company. Ore consists of magnetite and hematite. The deposit, which occurs in a belt of limestone, is of the contact metamorphic type, according to Fettke, and was formed by emanations from the same magma which gave rise to a quartz diorite batholith in the vicinity. Tonnage estimates by different engineers vary from 368,000 to 20,000,000. The ore is apparently of satisfactory grade, containing about 65 per cent of iron and being low in sulphur and phosphorus. Exploratory workings are almost completely obliterated, so that it is now impossible to appraise the tonnage. An examination to determine whether the deposit is large enough for exploitation would therefore be costly. Mineral rights were granted by the Spanish Crown to Pedro and Jose Santisteban, and are now owned by the former's widow, who resides in Bilbao, Spain.

According to official statistics, 2,700 lb. of gold was produced in the district near Corozal and sent to Spain from the year 1509 to 1536. Peons still wash gold in bateas along the Corozal River and some of its tributaries, recovering about 50c. in one day's work. An attempt at lode mining has been made by Henry D. Sayre, an American, whose daughter is now the owner of the property. The deposit consists of a series of quartz stringers and veinlets carrying gold; the country

Sketch map of Porto Rico showing situation of mineral deposits



One of the excellent military roads of the island

rock is presumably a weathered andesite tuff. This property was examined thoroughly about ten years ago by Dr. John H. Banks, of New York. In one tunnel the vein averaged 44 in. in width and $12.28 in gold over a length of 60 ft. All the tunnels are now caved and inaccessible.

A little lead ore was mined by the Spaniards near Carmen, about 5 miles from Guayama, in the 'nineties. About ten years ago some exploration work was done in the same district by P. Nelson and Colonel George R. Shanton. About 600 tons of ore is said to have been shipped during the period of operation. The last shipment made, according to reports, averaged about $35 per ton, but the remnant of a dump from which this last shipment was supposedly made contains only 2 per cent lead and no precious metals. Samples from the fractures exposed in the tunnel driven by Nelson and Shanton proved barren. The land is owned by Sr. G. Cautiño, of Guayama, and by the Sucesion Navarro.

Conditions in Porto Rico would be favorable to mining operations: The climate is ideal, transportation would nowhere constitute a serious problem, as none of the properties is far from automobile highways, and labor is abundant; moreover, the country is poor and in dire need of some such industrial undertaking. Unfortunately, the showings made by the little work that has so far been done in a rather desultory fashion offer no great encouragement for spending money on further exploration.

I do not want to close this brief account without expressing my appreciation to David Noble, a civil engineer of San Juan, who is well acquainted with the mineral deposits of Porto Rico and always willing to guide and help the visiting engineer.

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Phosphate Supply Adequate

AMERICAN production of phosphate rock in 1927 was more than 3,000,000 tons, with a total market value of over $11,000,000, out of a total world production of about 10,000,000 tons, reports a recent issue of the *Industrial Bulletin* of Arthur D. Little, Inc. In 1927 about 30 per cent of the American production was exported, 90 per cent of the remainder being worked up for fertilizer and the rest used in the manufacture of phosphorus and chemicals.

Although the quantity of phosphatic materials used for other purposes than fertilizers is relatively small, such uses are nevertheless rapidly growing in importance. Phosphoric acid is now being produced directly from phosphate rock in electric furnaces. It promises to displace sulphuric acid from certain industrial uses in which a phosphatic byproduct would find a market as a fertilizer. Tri-sodium phosphate is an important water softener in the laundering, textile, paper, and tanning industries. The United States uses over 20,000 tons of this salt yearly. Phosphates are also used in considerable quantities in the fireproofing of wood, and are the basis of the Parker process for rust-proofing iron. Baking powder, certain kinds of glass, ceramic materials of many sorts, and several types of dental cements contain phosphates. New applications are being developed very rapidly in almost every field of industry.

Fortunately the United States possesses almost unlimited reserves of phosphate rock. Deposits in Idaho, Utah and Wyoming are said to contain several billion tons, as yet practically untouched. The great deposits in the Southern states should last for several generations. There is, however, great need for improvement in the mining processes. In most of the fields, the phosphate rock occurs as pebbles in the beds of ancient water courses intermixed with chalky or sandy material. It has usually been mined by a simple washing process, which saved only the coarser pebbles. The rejected fines contain sometimes more than 50 per cent phosphate, and millions of tons of rich material go to waste.

MINING COPPER

Details of Methods and Costs

By C. H. McNAUGHTON[1]

Mine Superintendent,
Tennessee Copper & Chemical Company.

TENNESSEE COPPER operated two mines, the Burra Burra and the Eureka, in the Ducktown district, during 1928. The Burra Burra mine is much the larger and is the chief source of the ore smelted and treated in the company's smelter and acid plant at Copperhill, 4.5 miles from Ducktown. This mine operates steadily and furnishes a regular output of about 40,000 tons per month. The Eureka mine is operated irregularly and produces a much smaller tonnage of high-sulphur ore, the rate of output depending upon the demand for sulphur. During 1928 about 60 per cent of the combined output of these mines was shipped directly to the smelter, and the balance was concentrated before shipment in the flotation plant near the mines.

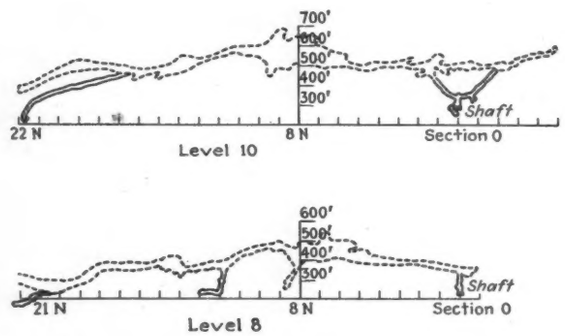


Fig. 1—Plans of orebody on two levels

The author acknowledges the assistance of Lamar Weaver, assistant mine superintendent of the company, and of C. F. Jackson, mining engineer, U. S. Bureau of Mines, in the preparation of this paper. U. S. Geological Survey Professional Paper 139, by W. H. Emmons and F. B. Laney, has been drawn upon for information contained in the paragraphs on history and geology.

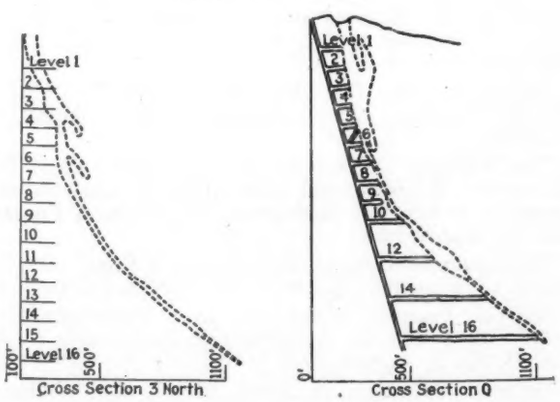
In 1847 secondary copper ore was mined from the Burra Burra lode and gossan ore from the Cherokee mine. Mining in the district has been continuous since then except for three years during the Civil War and from 1877, when the rich secondary ores were exhausted, to 1891, when progress in the metallurgy of copper and the completion of the Marietta & North Georgia Railroad from Knoxville to Atlanta made the treatment of lower-grade ores profitable. Up to 1891 several small mines in the district had been operated by individual companies. The Tennessee company was organized in 1899 and acquired by purchase the Burra Burra, London, Boyd, and Chulchote properties, and, by lease, the Polk County properties. The smelting plant was erected at Copperhill on the Ocoee River, and a standard-gage railroad built from Copperhill to Ducktown with spurs extending to several mines. The works and shaft were begun in 1899, and mining was begun in 1901. Although the company's ores were of lower grade than those previously worked in the district, the costs were low. In 1903, when this company produced 10,000,000 lb. of copper, the costs were 8.2c. per pound.

Geology. The rocks of the district all belong to the Great Smoky formation of Lower Cambrian age and are almost wholly metamorphosed sediments consisting mainly of graywacke with arkose, graywacke conglomerate, conglomerate, mica schist, slate, staurolite schist, and garnet schist in the order named. The orebodies are described as replacements of a limestone bed thickened in places by thrust folds and by strike faults in the bodies themselves.

The Burra orebody has a general strike of N. 62 deg. E. and dips 75 deg. SE. at surface, flattened to 50 deg. at the sixteenth level with local dips as low as 35 deg. It is over 2,300 ft. long on the fourteenth level of Burra mine, where the minable thickness varies from a few feet to a maximum of 180 ft. The plans (Fig. 1) show its general shape on two levels, 200 ft. apart vertically. The cross sections (Fig. 2) show the irregularities and changes in shape and dip from the surface to lower levels.

The immediate wall rocks are highly metamorphosed

Fig. 2—Cross sections of orebody at Section O and Section 3 N in Fig. 1



[1]Also one of the consulting engineers, U. S. Bureau of Mines. Printed by permission of the Director, U. S. Bureau Mines.

at DUCKTOWN, *Tennessee*

schists and graywackes, the bedding planes of which parallel the ore in dip and strike. The schistosity in general, but not always, parallels the bedding. The tendency is to break along bedding planes rather than parallel to the less prominent schistosity. In general, the walls may be said to stand well, and spans of 100 ft. are usually self-supporting except where the ground is fractured because of folding.

The ore itself is characterized by but few prominent slips and joints, which, where they do appear, are generally horizontal. Spacing of prominent slips and joints is measured by feet rather than by inches. The ore tends to adhere to the walls instead of breaking to them. It is not self-supporting over as long spans as is the wall rock. Haulage levels stand without artificial support in both ore and wall rock. In the zone of primary ore, to which mining has been confined since the present company started operations, the principal ore minerals are massive sulphides: pyrrhotite, pyrite, and chalcopyrite. The ores also contain small percentages of zinc in the form of sphalerite. Gangue minerals are chiefly lime-bearing silicates, quartz, and calcite, with which the sulphide minerals are intergrown. The ore tends to break in large angular blocks and slabs which

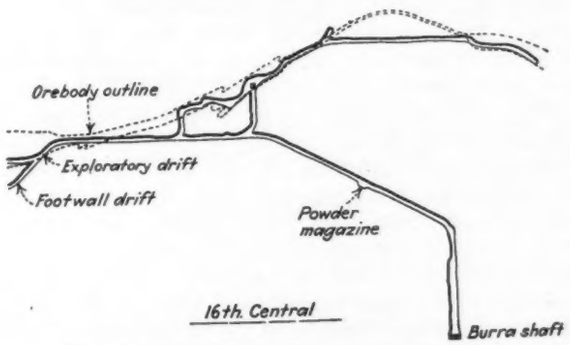


Fig. 3A—Typical level development, in plan, adjacent to Burra Burra shaft

wedge in chutes and hang up on flat stopes. For further details regarding the mineralization, the reader is referred to U. S. Geological Survey Professional Paper 139.

The average grade of ore is 1.6 per cent copper, 24 per cent sulphur, and 32 per cent iron. However, the grade of the ore differs considerably in the different sections of the mine. Ore from 16 to 24 per cent sulphur is shipped to the flotation plant for treatment, and that from 24 to 28 per cent sulphur goes directly to the blast furnace. To produce the tonnages of the foregoing grades as required by each of these plants it is necessary to mine from more stopes than would be needed if only one grade of ore was demanded. This situation also complicates the handling, haulage, and hoisting problems.

Since the ore zone is practically continuous, exploration is conducted principally by sinking, crosscutting to the ore zone, and drifting on the strike of the orebody. The orebodies are outlined by crosscutting holes from the exploratory drifts. Long holes are diamond-drilled, whereas holes less than 150 ft. long are drilled with a

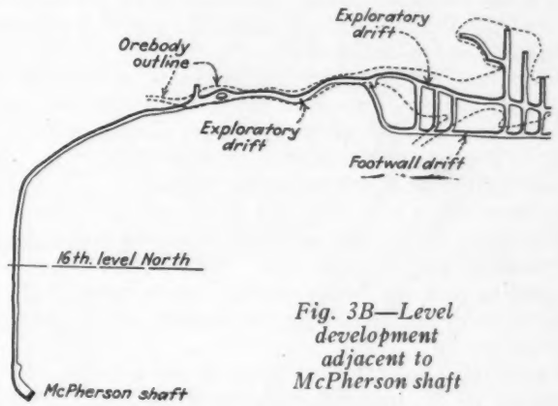


Fig. 3B—Level development adjacent to McPherson shaft

deep-hole hammer drill. The last diamond drilling was done by the company with its own equipment and cost $2.50 per foot. Assay records, diamond-drill cores, and deep-hole cuttings are filed; these file records are practically complete for more than twenty years.

Sampling and Estimating Reserves. The Burra Burra mine is laid out in 100-ft. blocks, measured along the strike and from track to track of haulage levels. These blocks are designated by the level, direction, and distance from Burra Burra shaft. Tonnage is estimated by blocks after drifting through them on both levels and crosscutting the four corners with drill holes or drifts. A factor of 8.1 cu.ft. per ton is used in computing tonnages. Grab samples are taken twice weekly in the stopes and daily in development headings. Assays for copper and sulphur are recorded by blocks and used to control the grade of production. Assay values of ore reserves of the entire mine are computed yearly. Blocks containing active stopes are given the grade of the last 50 assays from the stopes in these yearly estimates. New blocks are given a weighted average grade based upon development and drill-hole assays. In practice this method has proved accurate for all practical purposes.

Development and Mining

The Burra Burra mine is developed from two shafts, 2,200 ft. apart, measured along the strike of the lode (Fig. 3*A* and Fig. 3*B*). The Burra shaft is an inclined shaft sunk in the footwall at an angle of 74 deg. 30 min. from the horizontal. At the surface it is 100 ft. from the footwall and at the bottom, or 1,600 level, it

is 650 ft. therefrom. The McPherson shaft is a vertical shaft starting in the hanging wall at surface, cutting through the vein at the sixth level, and bottoming on the sixteenth level at a distance of 650 ft. from the footwall.

The Burra shaft is a three-compartment shaft 6x18 ft. 6 in., measured inside the timbers. Two compartments are used for hoisting with skips in balance, and the third compartment serves as a ladder, pipe, and power cableway. The shaft is timbered with regular shaft sets over most of its length, but in part of it, where the ground is especially strong, only sills and dividers are employed for support of the track. The McPherson shaft is 6 ft. 6 in. by 16 ft. inside of timbers, and has three compartments—two for hoisting with cages in balance and the third serving as a ladder, pipe, and cableway.

During 1928 practically all the ore was hoisted at the Burra shaft and the McPherson shaft was used for handling supplies and waste from development work. During 1929 it is planned to equip the McPherson shaft with 4-ton skips and divide the hoisting of ore between this and the Burra shaft. Most of the supplies will then be handled at the Burra shaft.

Levels are opened from these shafts at vertical intervals of 196 ft. Crosscuts are driven to the ore zone, and drifts are run therefrom in the ore to connect the two shafts. Because of the irregular outline of the ore zone it has been found impracticable to follow either wall with these drifts, and they are driven to make the connecting distance between shafts as short as possible and at the same time stay in ore. These drifts serve for prospecting and are locally termed "exploratory drifts"; parts of them are used later for haulage where the orebody is narrow.

Where the exploratory drilling shows a width of ore exceeding 40 ft., haulage drifts are afterward driven in the footwall 20 to 30 ft. from the ore and are kept as straight as possible. From these longitudinal exploratory and footwall drifts, crosscuts are then driven to the

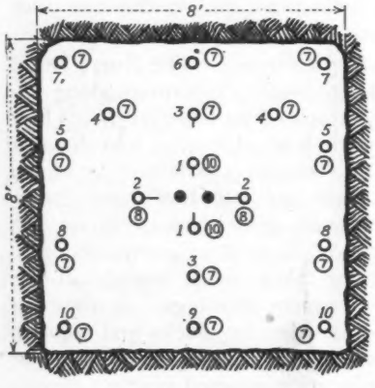


Fig. 4 — Placing of holes in an 8x8-ft. drift round

hanging wall at 40-ft. intervals along the strike. Where the ore is less than 40 ft. wide, the exploratory drifts are widened to the footwall—leaving pillars, however, where necessary to keep the opening less than 18 ft. wide.

Several years have passed since any shaft sinking has been done, and no shaft-sinking data comparable with those for other classes of work now being done are available. In recent years the shafts have been deepened by raising.

Exploratory drifts and haulage drifts are driven 8x8 ft. Fig. 4 shows a drift face and the standard drill round employed. Two center holes are drilled straight in but are not blasted. Two cut holes (1) and two easers (2) are loaded and shot, using No. 8 caps on fuse. If these holes do not break bottom they are reloaded and shot with the rest of the round. The usual round pulls 5 to 5½ ft.

As a rule no effort is made to obtain speed in drifting; experience has proved that the lowest per-foot cost of development is obtained by driving at the rate of 100 to 140 ft. per month. Drilling and blasting are done on the night shift by two contractors using two 144-lb. Leyner-type drifting machines mounted on columns with arms. The contract price for drilling and blasting is $5.50 per foot of advance for average ground, with a 50c. decrease for soft ground and increase for hard ground. This price covers the drilling and blasting labor and cost of dynamite.

The muck is hand-loaded on the day shift by two men in each heading, who are paid at the rate of 20 to 30c. per ton according to the length of tram, car service, and ventilation.

At present a long crosscut of standard cross section (8x8 ft.) is being driven to connect with the Eureka mine. Speed is desired in this operation, and an advance of about 500 ft. per month is being made. A scraper operated by a double-drum 25-hp. electric hoist, mounted on a portable frame of mine-track gage upon which is supported a steel incline for loading into 4-ton mine cars, is used for mucking out the face. Cars are spotted by a cable-reel locomotive. Sidings for empty cars are kept within 700 ft. of the face. It has been found that the few minutes employed in switching cars do not delay the operation, since this time is well employed in preparing the muck pile for easy loading.

The drill crew comes in at 7 a.m. and, with a clean set-up, starts drilling with two 144-lb. drifting machines, mounted on columns. At 9 a.m. the round is usually finished and is shot and the smoke blown out by 10 o'clock. The ground breaks better than the average, and generally the entire heading is shot in one operation. The mucking crew comes on at 9 o'clock and is occupied in oiling and overhauling the equipment in readiness for operation by 10 o'clock, when mucking starts. While the face is being mucked out, the drill men overhaul their equipment, send out dull steel, bring in and sort fresh steel, and take a short rest period. The round is usually mucked out by 12 o'clock, noon. A second round is drilled and shot by 3 o'clock. Two shifts each of drillers and muckers pull and muck four rounds, making an average advance of 18 ft. per day of about 20 hours.

Each drill crew consists of two drill runners, one of whom acts as shift leader; two drill helpers, and one steel nipper. The steel nipper assists the mucking crew on his shift in addition to keeping the drill crew supplied with steel. The mucking crew consists of a hoist operator, a helper who works at the face, and a motorman who spots and changes cars. The motorman also hauls and dumps the loaded cars while the drill crew is working at the face. A foreman has responsible charge of both shifts.

This task is organized on the basis of two high-pressure work periods for each crew, with an intervening period of rest. Rates paid for the completion of two rounds on each shift are: shift leaders, $8.16; drillers, $7.16; shovel operator, $7.16; drill helpers, $6.16; steel nipper, $5.16; scraper helper, $5.16; and motorman, $4.08.

With the exception of the motorman's rate, which is the standard, these rates are 40 to 90 per cent above

the standard daily wage. If the two rounds are not completed, the men receive only the regular daily rate.

Sublevel drifts are driven 4x6 ft. in cross section, with one drill of the type used in driving in level headings. One driller and a helper are employed drilling in each drift. One or two muckers using wheelbarrows muck out on day shift. These drifts are not timbered.

Raises are usually 4x5 ft. in cross section and are drilled with light, hand-rotated, wet stoper drills. The raises are not timbered, and drilling is done from staging that is supported on sprags which are wedged between the walls.

Table I—Development Data

	8x8 Ft. Drifts	Subdrifts	Raises
Explosives[1] pounds per ft.	11.2	9.5	8.8
Average advance per day, ft.	4.84	5.20	3.66
Number of men per day	4	4	2

[1]Special bulky dynamite of 35 per cent bulk strength.

Early Methods of Mining

Prior to 1910, ore above the sixth level was mined by underhand stoping in open stopes with irregular pillars supporting back and walls. Spans of 50 ft. or more were common between the pillars. A large percentage of the ore left in pillars has since been recovered from drifts driven in the footwall close to the vein.

Later on, shrinkage stoping was employed, first on timbered drifts and then on ore pillars above the haulage levels. Above the tenth level these stopes were carried longitudinally and practically the full width of the ore. Below this level transverse stopes, 80 ft. wide with 30-ft. pillars between, were employed in wide ore, and longitudinal stopes were used in narrow ore. The stopes were pulled empty and filled with waste drawn from caved levels above.

The Present Mining Method

In 1925 the sublevel stoping method was introduced on the fourteenth level and is now the principal method employed, although only 32.6 per cent of the total production during 1928 came from sublevel stopes. Production in 1928 was divided as follows:

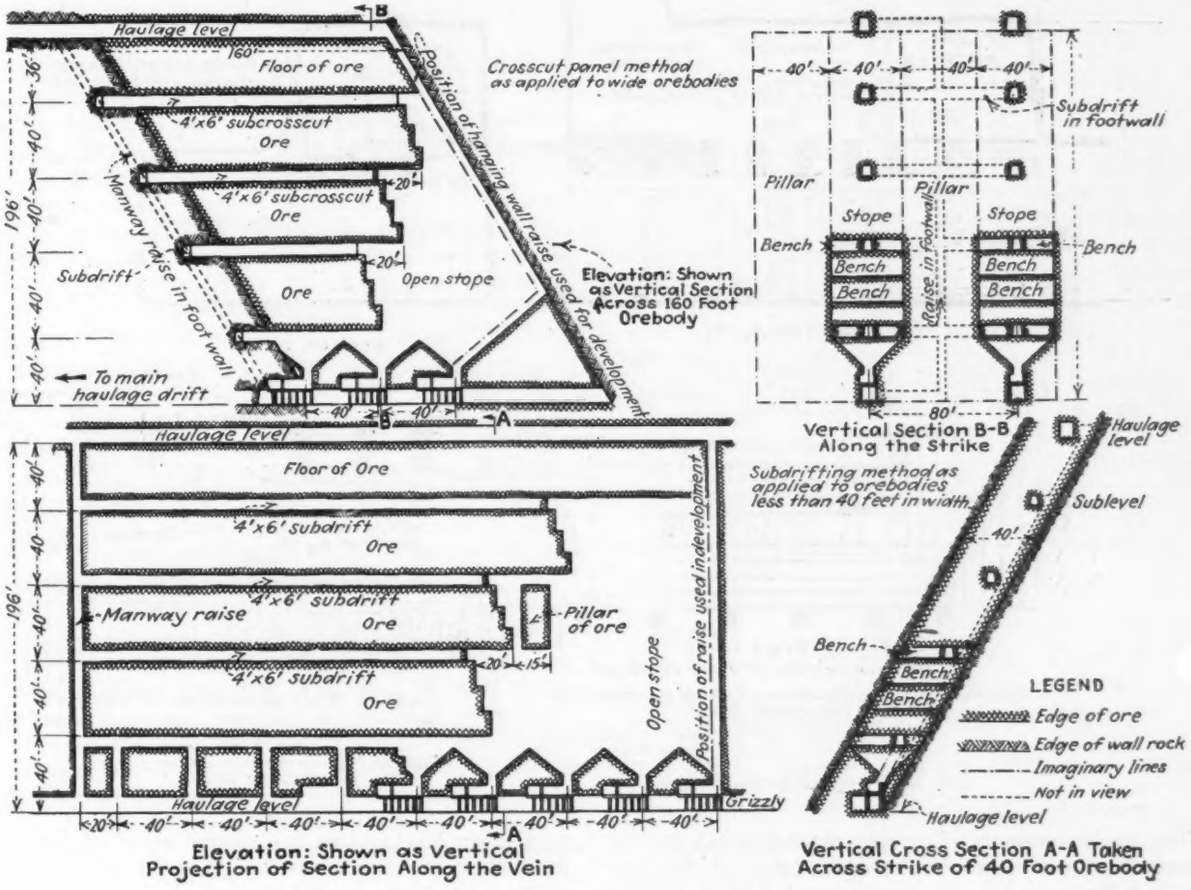


Fig. 5—Method of developing and mining sublevel stopes

Production Record for 1928

	Per Cent
From sublevel stopes	32.6
From ore pillars under old shrinkage stopes	23.3
From shrinkage stopes	9.0
From breaking floors and pillars, mostly on the upper levels	17.6
From flat stopes and pulling caves	12.4
From development in ore	5.1

Sublevel Stoping—Where the orebody is less than 40 ft. wide, sublevel stopes are run longitudinally and the full width of the ore. Fig. 5 shows the method of developing and mining a longitudinal sublevel stope. The block to be stoped is developed by long raises driven on the footwall to the level above. In the block shown in the illustration, two of these raises were driven, one at each end of the block. An intermediate raise was driven to the third sublevel for the purpose of speeding the development. At 40-ft. intervals along the haulage drift, 4x5-ft. raises, called "pull holes," are driven on the footwall to the first sublevel. Sublevel drifts are at vertical intervals of 40 ft. connecting the long end-raises

and driven from each raise to meet near the center of the block.

Before stoping starts, grizzly chambers (Fig. 6) are opened up over the haulage drift at one end of the block. The grizzlies are installed immediately over the drift timbers without the provision of storage capacity below. the end of the block and thus providing a bench from which down holes may be drilled to form a second bench 6 ft. lower down. Another slab is then shot off the sublevel, and the breaking operation is repeated, benching through to the back of the first sublevel. This operation is carried out on successive sublevels; the work

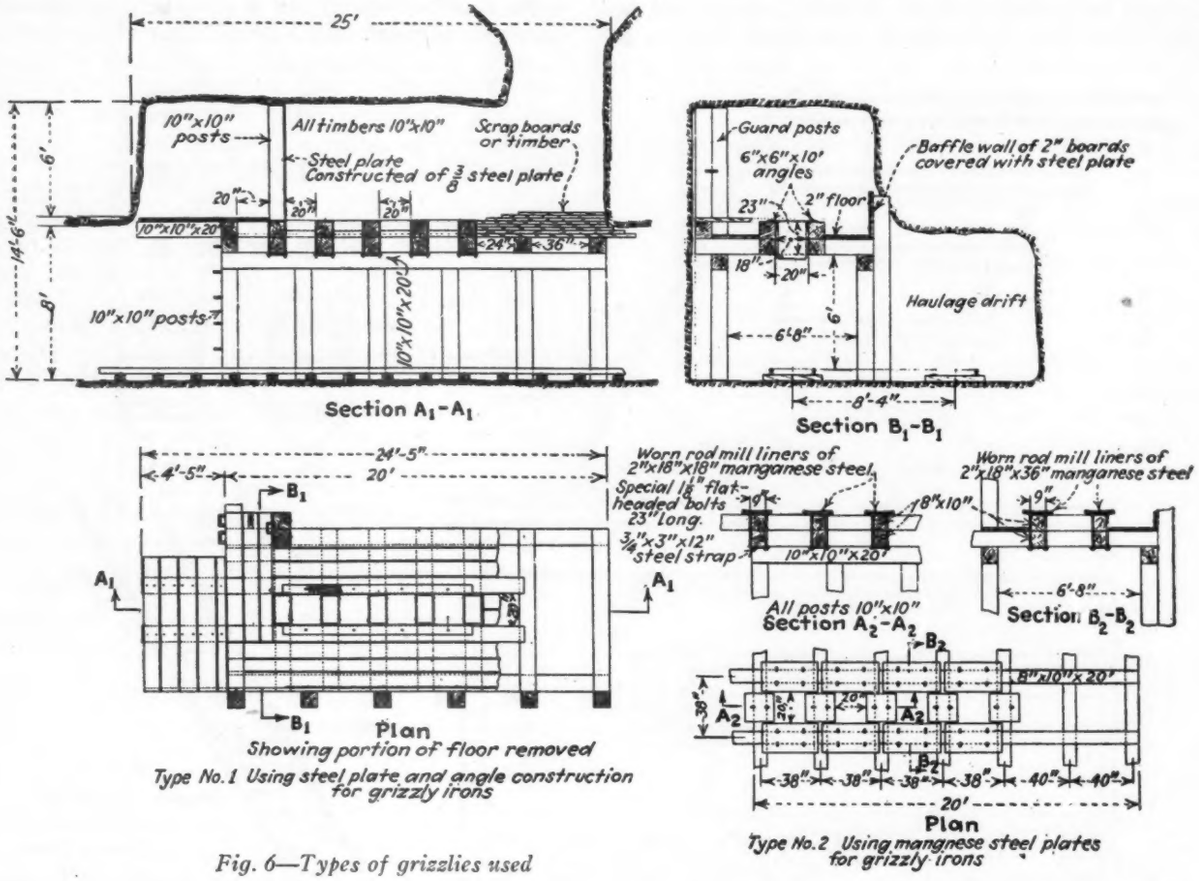


Fig. 6—Types of grizzlies used

The total amount of stope development, as distinguished from level development, required for preparing a stope in ore, 40 ft. wide and 320 ft. long, is as follows:

	Feet
Two long raises between levels	450
Four sublevels	1,360
Eight pull holes	400
Total development	2,210

The tonnage developed in this block, exclusive of that in ore floor and in pillars over the haulage drift, is 206,000 tons. Thus 1 ft. of development is required for every 93 tons of ore prepared for first mining. This development also assists later in the extraction of the pillars, which contain an additional 103,000 tons, 60 per cent, or 62,000 tons, of which can later be recovered in robbing operations. The total recoverable ore per foot of stope development is, therefore, 110 tons.

Stoping is started at one end of the block, after first funneling out the pull holes by drilling downward from the bottom sublevel and at the same time slabbing off the hanging-wall side of the subdrift exposing both walls (Fig. 5). Beginning at the long raise and on the second sub, the drift is slabbed to expose the walls, and the raise is benched out to the full width of the ore. A slab about 5 ft. thick, 6 ft. high, and extending from wall to wall is then shot off the sublevel, retreating from on a lower level is kept far enough ahead of that on the level above to assure that the men are always working under protection of solid ground.

The bench offsets are so proportioned that men working on the benches intermediate between sublevels are never under ground that cannot be tested from the sublevel with a 15-ft. bar.

At the Burra Burra mine the benching is done entirely with down holes. In this respect the practice differs from that in many other mines employing sublevel stop-

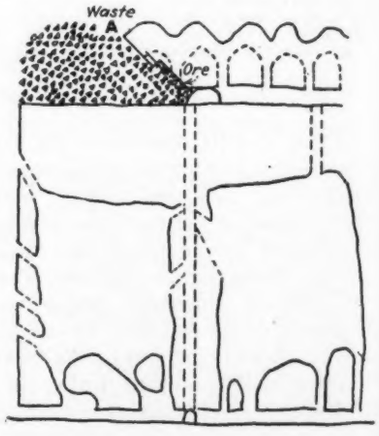


Fig. 7—Sketch indicating method of extracting pillars

ing in which the benches are drilled both up and down from the sublevel drifts and where intermediate benches are not employed.

The first bench below the sublevel is drilled to a depth of 6 ft. and the following benches are drilled to 10 ft. Usually two men work together on a sublevel. Drifting machines are employed for cutting-in or slabbing on the sublevels and jackhammers for drilling the benches. Both types are operated as one-man machines. The slabbing rounds are drilled with three holes in a vertical row to a depth of 10 ft. with 2 to 2½ ft. of burden on each row of holes. Usually nine holes can be drilled in a shift.

Bench holes are drilled 4 to 5 ft. apart along the face of the stope with a burden of 2½ ft.

Blasting in the stopes is done at night by a blasting crew using a bulky 35 per cent powder and electric detonators fired from the 250-volt mine circuit.

Drilling in stopes is done on contract at a price of 7c. per linear foot of hole drilled. The drilling is closely supervised to insure that the holes are properly placed. An average of 48 tons per drill man-shift is broken in the stopes, with a powder consumption of 0.33 lb. per ton of ore. These figures include opening of the stope, cutting grizzly chambers, and incidental labor.

The ore broken in the stope falls to the funneled raises or pull holes above the grizzlies and is worked through the grizzlies directly into cars on the haulage level. An average of 72.5 tons per man-shift is put through the grizzlies, with a powder consumption of 0.167 lb. per ton of ore. Cars are spotted at the grizzles in trips of four. When a car is filled, the grizzly man goes to the level and moves another car into position.

Where the orebody is wide the sublevel stopes are opened up 40 ft. wide, across the strike of the orebody, with 40-ft. pillars between them. These stopes are developed from the crosscuts on the haulage level in the same manner as the narrow longitudinal stopes are opened from the longitudinal drift. Fig. 5 shows this development and method of mining. To date no pillars between sublevel stopes have been extracted, but the method of recovery will be the same as that employed in recovering the pillars between the old shrinkage stopes, as will be described.

Robbing and Pillar Extraction—Fig. 7, an ideal longitudinal section, illustrates the method of robbing and of extracting stope pillars, beginning at the upper levels with the pillars over the old haulage drift beneath the shrinkage stopes. Starting at the end of the block to be robbed, as at *A*, an inclined cut or slice is taken in the haulage-drift pillar from wall to wall, at an angle corresponding to the angle of repose of the caved waste. After the slice is blasted, the broken ore is mucked out and trammed to the ore pocket. The driller then goes back and drills a round from the face of the preceding break. This procedure is continued till the last round breaks through into the broken waste above, letting it down to fill the opening. Another slice is then started further back and the cycle of operations is repeated. In this manner the entire pillar is robbed back from one end of the stope to the other. When this is done the weight of the broken waste is carried on the floor pillar.

The next step is the recovery of the pillars between the transverse shrinkage stopes which had been mined from the next haulage level below. The pillar is first partly undercut at an elevation about 50 ft. above the level, blasting the broken ore into pull holes of the old stope. Then, using deep-hole hammer drills set in

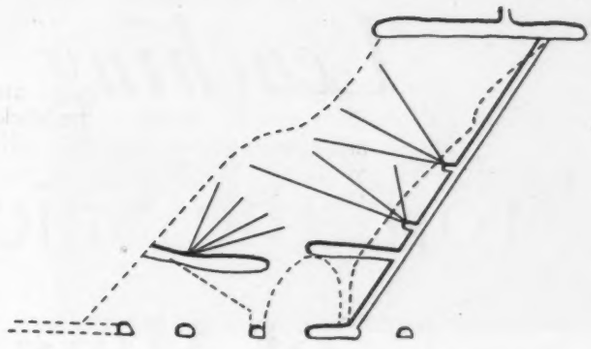


Fig. 8—Sketch indicating method of extracting pillars with deep holes

stations cut from the footwall raise opposite the middle of the pillar, long holes are drilled as shown in Fig. 8. Their depth varies from a few feet to 120 ft. The holes are drilled and several rounds shot, beginning at the bottom. Sixty per cent gelatin is used, being detonated with cordeau. The charge was figured at 0.1 lb. explosives per ton of ore and the holes were charged two-thirds full and stemmed to the collars with clay cartridges. The explosive used was made up in 2x16 in. sticks. Usually the ground broke well, but some large blocks broke off behind the holes.

The floor pillar is recovered by drilling long slabbing holes from stations on the footwall and blasting the ore into the pull holes. Slabbing is continued until the floor pillar fails and breaks into the stope, followed by broken waste.

(To be continued)

Production of Fuller's Earth Increased in 1928

THE fuller's earth sold or used by producers in the United States in 1928 amounted to 287,012 short tons, valued at $3,895,991, according to an announcement by the U. S. Bureau of Mines, which has collected statistics in co-operation with the geological surveys of Florida, Georgia, Illinois and Texas. This is an increase of 9 per cent in quantity and 3 per cent in value compared with 1927. Every producing state except Georgia showed an increase, and one state that has not reported production for many years—Colorado—re-entered the list of producers. Georgia was the leading state in production in 1928, with Florida second and Nevada third. These three states produced 77 per cent of the total output. Average value per ton of fuller's earth was $13.57 in 1928 compared with $14.24 in 1927.

Until 1895, when fuller's earth was successfully produced commercially in Florida, the United States was entirely dependent on foreign supplies. In 1928 the imports of fuller's earth were 7,592 short tons, valued at $132,003, practically the same in quantity, but an increase of 21 per cent in value, compared with the value in 1927. Exports of fuller's earth are not separately shown in the official records of the foreign commerce of the United States, but eight producers reported to the Bureau of Mines that in 1928 they exported 16,494 short tons of fuller's earth, which was an increase of 34 per cent over the record for 1927.

Leaching Manganese

From the Siliceous Iron Ores of Minnesota—II

By CARL ZAPFFE

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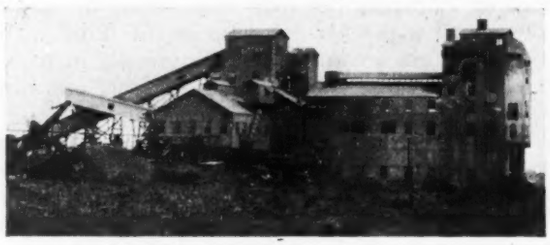
The Bradley process for leaching manganese from siliceous iron ores, which has been developed in the Lake Superior region, was described briefly in the first installment of this article, which appeared in last week's issue. A flow sheet accompanied Part I. Details of the process are discussed in the present installment, with which the article concludes.

IN THE preceding issue, various steps and stages were outlined in a general manner. Even at the risk of repetition, it will probably be of benefit to go further into the details pertaining to the several phenomena that arise and the pieces of apparatus which experience has proved the more desirable ones to adopt.

The fundamental features of the process are: making both a manganese ore and an iron ore; effecting a separation of manganese and iron by means of selective roasting; leaching the manganese from the roasted ore by using ammonium sulphate; precipitating the manganese by using the ammonia gas generated during leaching; fixing the precipitate by oxidizing with air; breaking down and re-forming the ammonium sulphate, so that daily very little additional ammonium sulphate beyond that originally charged into the system is required; washing the manganese precipitate and the iron-silica residue and evaporating the liquor to conserve the dissolved salts in the moistures of these two products, and to reduce the sulphur content; drying the precipitates; magnetic wet-concentration of the iron-silica residue; sintering the manganese- and the iron-concentrates. These several features may be conveniently described in five steps. The capacity of a given plant should be considered in terms of manganese sinter, rather than raw ore, and the capacity of the auxiliary services should be equal to maintaining a full production of manganese, irrespective of the amount of crude material required, which will vary with the content of manganese in the crude material.

The ore will in all probability be crushed at the mine, but can be crushed at the unloading track-hopper, using a jaw crusher, to pass a 4-in. ring. As indicated in the flow sheet, it will pass over a vibrating screen, and the coarser material will be crushed again to minus ¼-in. in a Symons cone crusher. From this point it is assumed that the operation will be continuous and conducted on a 24-hour basis.

Leaching action was found to be preferably conducted with material which will pass through a 65-mesh screen. This reduction in size is best performed by grinding wet, on account of lessened cost and avoidance of dust; for this a Hardinge ball mill and a standard Dorr



Sintering plant at Evergreen mine, Cuyuna district, Minn. Sintering manganiferous ores to develop better structure is an innovation in the Lake Superior region.

classifier have been used. Fine grinding and classifying are in closed circuit.

The overflow from the classifier goes to a Dorr thickener and thence to a vacuum filter, by means of which it is proposed to reduce the moisture content in the ore to perhaps 10 per cent. With this percentage the material will be easily handled. The filter cake will be discharged by means of a belt conveyor into a storage bin, from which it is fed by gravity into a drying kiln.

Methods and equipment referred to in the foregoing have been standardized by long practice, and no difficulties in design will be encountered. In the subsequent steps the equipment used is fully developed mechanically and presents only problems of proportion and design, owing to the novelty of its proposed use. These problems are chiefly matters of size and proportion in order to secure the desired capacity.

The reasons for the procedure in this step are of a chemical nature. The process is applicable to ores containing the minerals pyrolusite, psilomelane, and manganite, which are oxides, and rhodochrosite, the carbonate of manganese, which in the roasting would be changed to an oxide. Rhodonite, the silicate of manganese, cannot be reduced except at very high temperatures, and much the same is true of braunite (Mn_2O_3).

The purpose of this step is to make manganese

monoxide (MnO), because it is completely soluble in ammonium sulphate, whereas the higher oxides are not soluble; also, by using the lower temperature (not to exceed 800 deg. F.), the iron present is not changed to the ferrous state. In the ferrous state iron is soluble in ammonium sulphate; and, under favorable conditions, will be acted upon in a manner similar to manganese, which would involve further treatment to separate the manganese from the iron. Such treatment is possible, but it is less convenient and more expensive than is the separation in preliminary roasting. Selective roasting, therefore, made possible avoiding certain inconveniences in the leaching step and made possible the recovery by magnetic concentration of a valuable byproduct of iron ore.

Experimental work showed that, at a temperature not exceeding 800 deg. F., MnO_2 will be reduced to MnO, and Fe_2O_3 will be reduced to Fe_3O_4, with a comparatively small production of free FeO, the latter corresponding to 10 to 20 per cent of the total iron present, which is desirable in a measure. It has also been discovered that the reduction to MnO precedes that of iron to FeO, and the latter substance does not form until nearly all the manganese is in the form of MnO.

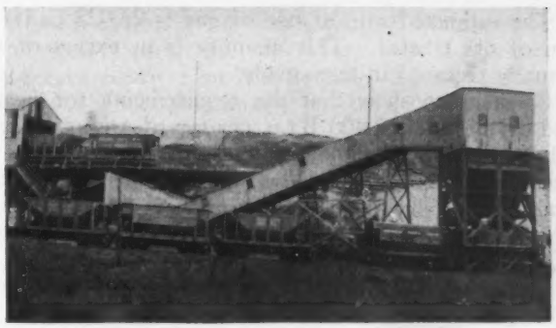
Various Types of Furnace May Be Used

The reducing roast may be carried on in a Wedge-type, multiple-hearth furnace, in a rotary kiln, or in other types in which the ore may come into contact with reducing gas and in which a maximum temperature of 800 deg. F. is mechanically possible. Inasmuch as an intimate contact between ore and gas is desirable, a furnace has been designed which makes possible lifting the ore-burden in small quantities and dropping it when the ore buckets reach various heights as they revolve within the furnace, and thus combine the advantage of easy control of gas obtainable with a Wedge furnace and the economy of gas inherent in the rotary kiln. The shell of the furnace designed does not revolve.

Gas used for reduction may be any reducing gas containing carbon monoxide or hydrogen. In the operation of the pilot plant water gas was used, and equally good results have been obtained with blast-furnace gas. In the use of water gas, selectivity of reduction was promoted by the presence of water vapor in the gas. With blast-furnace gas no additional moisture is necessary beyond that ordinarily carried in washed gas; but unwashed hot gas will be preferable to washed gas.

The processes of drying the ore after grinding, of pre-heating and of reduction, it is proposed, are to be

Crushing and screening at this plant facilitate blending manganiferous ores from Louise and Alstead pits, Cuyuna district, Minnesota



Crushing plant at Mahnomen mine, Cuyuna district. In this district manganiferous ores are crushed to facilitate grading.

carried on in two kilns, of which the one for drying and pre-heating will be an ordinary rotary kiln. Pre-heating is adopted because the hot gases from the reducing furnaces are available. It will be fired by the hot, partly oxidized gases coming from the reducing kiln, and a 40 per cent reduction in the ore is thus obtained, which becomes a substantial economy. The reducing kiln will be fired by blast-furnace gases to 750 deg. F., by partial combustion. The drying or rotary kiln is fed by wet ore coming from the pressure filter, and this dried or pre-heated ore is discharged into the second or reducing kiln. To pass a ton of ore through the reducing kiln will require 45 minutes.

The velocity of the gas in the drying kiln must be kept low to avoid dust losses. Escaping gases may go directly to the stack or may be subjected to a gas-washing operation, either by means of a vortex cleaner or a wet washer of the tower type. An alternative possibility lies in the construction and use of a scrubbing tower for wet washing. In this operation the Dorr thickener used to thicken the ore after grinding may be used, and the recovered dust deposited therein pass with the primary ore to the drying and reducing system. In any event, it is a matter of only a minor economy and is not essential at the outset. It is mentioned merely to indicate that dust recovery presents no difficulties if one wishes to attempt it.

According to estimate, if blast-furnace gas is used, the following approximate composition will carry on the process of reduction:

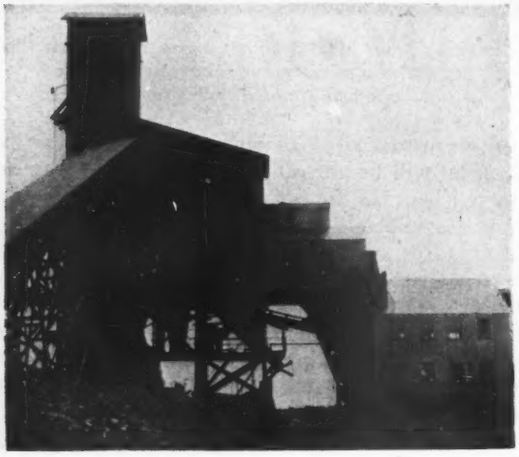
	Per Cent
CO_2	12.56
CO	25.12
H_2	3.29
N_2	55.65
H_2O	3.38

The assumption is made that this gas is received at the burner of the reducing chamber at a temperature of 60 deg. F. and a barometric pressure of 30 in. A portion of this gas is used for combustion, approximately 3,669 cu.ft. (16.6 per cent). This is burned with air in a Steinbart burner with 1 per cent excess oxygen. Heat derived from this combustion is used in raising the remainder of the blast-furnace gas to a temperature of 750 deg. F. The volume of the products of combustion and the blast-furnace gas, when mixed, will be 55,108 cu.ft. at 750 deg. F. The composition of this gas after combustion of the above portion and mixture with fresh gas, will be as follows:

	Before Reduction, Per Cent	After Reduction, Per Cent
CO_2	15.99	26.00
CO	20.03	10.01
H_2	2.62	1.31
O_2	0.01	0.01
N_2	58.01	58.01
Water vapor	3.34	4.66

The estimated rate of use of gas is 22,023 cu.ft. per ton of ore treated. This quantity is in excess of that actually required in tests made.

Calculations show that the requirements for heating and drying are 717,408 B.t.u. per ton of ore in the natural state, and the total heat released per ton of ore reduced is 358,154 B.t.u. The total sensible heat in gases available for drying and evaporation is 1,525,583 B.t.u. Allowing for a 5 per cent loss of heat, and deducting the



Jigging plant with Hancock jigs at Maroco mine, Cuyuna district, Minnesota. Jigging iron-bearing formation to make marketable ore is an innovation in the Lake Superior region.

units required for pre-heating and drying, the sensible heat in gases leaving the drying kiln is 731,896 B.t.u., for which some use may be found.

In actual operation, leaching the manganese is a step apart from precipitating the manganese; but, from the chemical standpoint, leaching and precipitating are so closely akin that the two steps may be conveniently considered together. This stage of the process is very simple indeed, although the points advanced may appear somewhat complicated. Its simplicity is the more appreciated when it is noted that leaching and precipitating manganese from one ton of ore requires only thirty minutes.

The reduced ore taken from the roasting furnace, after being cooled partly out of contact with air, is dumped into ammonium sulphate liquor, the latter at a temperature of about 190 deg. F., as it is obtained from evaporators which are in the circuit. The resulting action is known as digestion, and the tank in which it takes place as a digester. This digester consists of three shallow trays, and is equipped with paddles revolving on a vertical central shaft, for the purpose of promoting contact between ore and liquor in each tray.

The manganese oxide in the ore is dissolved in the liquor and becomes manganous sulphate. This reaction generates ammonia gas, which is withdrawn by an exhauster and piped to ammonia towers, or precipitators, for further use. In these precipitators the ammonia gas comes in contact with sprays of the liquor containing the manganous sulphate, with the result that the manganese is precipitated as manganous hydroxide. The manganous hydroxide requires to be further oxidized by atmospheric air in order that the precipitate may be stable, and heavy enough for settlement in the liquor. This is accomplished by entering atmosphere on the minus-pressure side of the ammonia gas exhauster and allowing the air to mix with the ammonia gas, the oxidation occurring in the towers as precipitation takes place.

Leaching and precipitation are both produced by the reversible chemical reaction. The direction in which the reaction proceeds depends on the degree of concentration of manganous sulphate in the liquor and on the excess of ammonium sulphate present. Control of the process is accordingly secured by the order in which the flowing liquor encounters the metals and the ammonia gas. It is desirable that the liquor going to the precipitator shall contain a maximum of manganous sulphate and a minimum of ammonium sulphate. In this condition its susceptibility to reaction with ammonia gas is at a maximum, and, consequently, manganese may be most readily precipitated.

For leaching, two digesters are provided. Final leaching, which involves the removal from the ore of all the manganese possible, takes place in the second digester. Ore coming to this digester has had approximately 60 per cent of its manganese removed in the first digester. The manganese which reaches the second digester is so limited in quantity, in comparison with the volume of liquor, that the most complete leaching possible may take place without greatly reducing the leaching power of the liquor. The partly saturated liquor in the second digester flows to the first digester, where it encounters fresh ore and leaches 50 to 60 per cent of the manganese, and then passes to the precipitator where the manganese is removed. Accordingly, the flow of liquor is from the secondary digester to the primary digester and thence to the precipitator; whereas the flow of the ore is from the primary to the secondary digester and thence to a residue tank. The surface of the liquor during digestion should be as large as possible and the depth a minimum. Using a tray type of digester, the depth of the liquor can be varied from 6 to 18 in., to regulate the time of detention.

The Action of Iron in Leaching

Leaching of manganese is 50 per cent or more complete before the leaching of iron begins. This fact operates to prevent the leaching of iron in the primary digester. It is also a law of this leaching process that where iron has been leached, it will be removed from the solution and replaced by manganese in the presence of a large excess of the latter, such as exists in the first or primary digester. Such iron, therefore, as is leached in the second digester may be thrown down as ferrous hydroxide after reaching the first digester. Iron so eliminated from the leaching liquor is not re-absorbed, but becomes part of the residual ore flowing from the primary digester.

Manganese precedes iron in leaching; wherefore iron precipitates more rapidly than manganese from the leaching solution. If necessary, by adding a little ammonia immediately before the liquor reaches the precipitator, an iron precipitate could be made in advance of the precipitation of manganese. This is offered only as an illustration of what could be done, but is not contemplated, and illustrates the flexibility of the procedure as well as the ease of the control of this step. Iron is, however, removed, or fixed, as already described, by selective roasting, and the digesters are relieved of this additional function. This leaching step results in two products. The principal one is the precipitated manganous hydroxide, which is received in a large settling tank to which the liquors from the precipitating towers

containing the precipitated manganese run. The other is the byproduct iron, a residue chiefly in the magnetic form (Fe_3O_4), resulting from roasting. This is received in the so-called iron-silica residue tank. Both products are in the form of finely divided ore. The time required to run one ton of ore through the preheater, reducing furnace, digesters and precipitators has been 1 hr. 45 min.

Washing and Drying the Precipitates

Both precipitates resulting from the leaching operation must be washed to reduce the final moisture to a point which permits sintering; also to reduce the valuable contents of the moisture contained in the final product to a negligible quantity, and to avoid an excessive sulphur content. The amount of water which must be added to the system for the purpose of washing is most important, because it is returned to the system and mingles with similar sulphate-bearing liquor and necessitates an equivalent evaporation from the main mass of liquor of the system, in order to maintain the concentration of the liquor at the most economical point. The ability to wash with a small amount of water may accordingly overbalance considerations of low first cost or of labor required with other methods. So far it seems that washing is best carried out with a vacuum filter and with a final drying, a waste-heat drier being used and 18 per cent residual moisture being allowed as a content suitable for sintering. It is likely that centrifuges may eventually be designed for ores in a fine state of division and prove more advantageous than filters.

From the iron-silica residue referred to, a large part of the magnetic iron is recovered by means of magnetic concentration. So far a magnetic log washer has been used, but a Grondal wet separator may prove equally applicable. Inasmuch as some FeO travels through the mill with the manganese, not all the original iron is recovered as iron ore. If allowance be made for the customary tailing product in all iron-ore concentrating work, at least 70 per cent of the total iron content of the crude ore can be recovered. Silica content of the ore will be below the customary limit at which penalties are invoked.

In some particles of ore, iron and manganese are combined mechanically, so that the process cannot separate them. As a result, the iron concentrate will contain around 2½ per cent manganese. On the other hand, the total recovery of manganese in the whole process becomes nearly 98 per cent.

Sintering

For metallurgical purposes sintering of both the manganese and the iron byproduct will be necessary. The manganese precipitate, after being dried with waste heat, exhibits a peculiar cohesiveness. It may sound like an incongruity, but this dried precipitate must be described as lumpy or pebbly when it is broken, such is the characteristic created by this cohesiveness. The lumps are of a size which makes sintering extremely easy.

Sintering the magnetic iron concentrate has been shown to present no difficulties. The moisture content must be closely controlled to obtain the best results; but such control is fortunately easy to obtain. A sintering unit may be included in the plant or a custom sintering plant may be used if one is available.

Provision is also made for evaporation of water added to the system. Waste gases are available for the production of steam, and a simple type of direct evaporator is all that is required. One evaporator is planned for the return liquor from the primary digester-manganese hydroxide circuit and another for the secondary digester-iron hydroxide circuit.

In the preceding descriptions only those features of the Bradley process are presented which are original or peculiar and for which special or novel provision has to be made. Aside from those features, the equipment consists of piping for the flow of liquors and gases, tanks for storage or subsidence, pumps for liquor, and exhausters for gas.

The only piece of apparatus in the entire plant (that would be required) which is mechanically novel is the reducing furnace which has been designed, and it is merely an improvement over other types as to control, economy, and more thorough reduction. All other apparatus is standard in every respect, and is built by companies of high commercial and technical standing.

A Flow Sheet of the Process

Provision of the several circuits required is easy, because so much of the material handled, after leaving the reducing-furnace department, is solids in suspension in liquids, or liquids only and gases, which may be shunted around through piping, and in and out of apparatus set at various elevations with respect to each other and where most practicable. To show the same diagrammatically is not as simple; and to prevent obscuring certain explanatory data, several separate circuits must be developed. The flowsheet (see the issue of June 29) has been prepared with the hope that it might illustrate details which the foregoing description has not developed sufficiently.

A plant of commercial size is not yet in operation, but a complete design of one has been prepared. The following data were determined for a plant that was to produce 50 tons of manganic hydroxide per 24 hours, or its equivalent in manganese sinter.

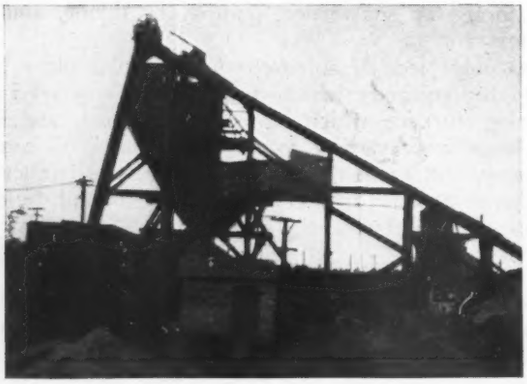
We may assume an output of 250 long tons of ore per day, requiring two 125-ton reducing furnaces. They will operate as long as is necessary to produce enough roasted ore to keep the balance of the equipment operating the full 24 hours. The crude ore used and the roasted ore produced are as follows:

Crude Ore Dried 212 Deg. F.	Per Cent	Roasted Ore	Pounds	
Mn	15.00	MnO_2	7.39	Mn 67.14 lb. or 20.56%
Fe	27.50	MnO	80.60	
SiO_2	24.56	Fe_3O_4	156.90	Fe 115.98 lb. or 35.45%
Al_2O_3	2.50	FeO	3.87	
CaO	1.00	SiO_2	66.10	
Combined water	8.90	Al_2O_3	11.67	
Moisture	.....		326.53 lb.	

That is, 326.53 lb. of roasted ore will be delivered to the primary digester per minute. The primary digester receives 5,000 lb. of ammonium sulphate liquor per minute. It contains 10 per cent, or 500 lb., ammonium sulphate and 4.12 per cent, or 206 lb., manganese sulphate, the latter having been obtained from washing the final iron-silica residue; also from the thickener before this precipitate was washed.

The contents of the primary digester pass into a primary thickener, from which the solids are taken that supply the secondary digester, whereas the liquor is conducted to the ammonia towers. This liquor measures 5,387 lb. per minute and contains 7.17 per cent, or 386 lb., of ammonium sulphate and 6.03 per cent, or 325 lb., of manganese sulphate. Here is noted an increase in manganese sulphate content (325-206) of 119 lb., with a loss in ammonium sulphate.

The liquor passes to the towers, where the manganese is precipitated, after which it is piped to a storage tank and drawn from the latter at the rate of 4,967 lb. per minute, containing 11.49 per cent, or 571 lb., of ammonium sulphate, and 2.96 per cent, or 147 lb., of manganese sulphate. The solids contained weigh 105 lb. and are 59.6 per cent, or 63 lb., of metallic manganese, 1.87 per cent, or 1.95 lb., of metallic iron, and 1 per cent, or 1.05 lb., of silica. This material is piped to the



Crushing plant at Merritt mine, producer of manganiferous ores, Cuyuna district, and incline from pit

manganic hydroxide thickener, and the sediment is the product later washed, dried, and sintered.

Every 24 hours 50 tons of manganic hydroxide and 80 tons of 10 per cent ammonia liquor are drawn off, the latter being recovered and sent to the evaporator and then into the secondary digester.

The secondary digester uses as its feed the material which has been partly acted upon in the primary digester. Liquid effluent from the manganic hydroxide thickener is part of the solvent used, being drawn at the rate of 5,200 lb. per minute and containing 568 lb., or 10.92 per cent, of ammonium sulphate and 147 lb., or 2.83 per cent, of manganese sulphate. To make the digestion of the manganese as near complete as possible, fresh ammonium sulphate is added to the mixture in the secondary register, thus providing an excess desired, which also takes care of variations in the composition of the ore.

Material drawn from the secondary digester is piped to a thickener and constitutes the iron-silica residue. It enters this thickener at the rate of 5,235 lb. per minute. The liquor contains 9.55 per cent, or 500 lb., of ammonium sulphate, and 3.94 per cent, or 206.5 lb., of manganese sulphate, which is the liquor piped to the primary digester for further loading with manganese. The solids consist of 4.68 lb. Mn, 156.9 lb. Fe_3O_4, or 112.97 lb. Fe; 65 lb. SiO_2, and 11.67 lb. Al_2O_3, which is washed, dried, concentrated, and sintered.

The ammonia gas generated in the two digesters is captured and piped to the precipitating towers, where it is used to precipitate manganous hydroxide from the ladened liquors conducted to them. The quantity of this gas per minute, at 60 deg. F., has been estimated as follows:

	From Primary Digester	From Secondary Digester	Combined
NH_3, lb.	26.78	13.39	40.17
Volume, cu.ft.	594.00	296.00	890.00

What takes place in the two digesters may be shown by setting down in columns the weights of the materials for each.

	Digesters Compared	
	Primary	Secondary
Liquid drawn off per minute, lb.	5,387	5,235
Sulphates in solution		
Ammonium sulphate	386 lb. or 7.17 per cent	500 lb. or 9.55 per cent
Manganese sulphate	325 lb. or 6.03 per cent	206 lb. or 3.94 per cent
	Solids Precipitated per Minute From This Solution by NH_3 in Precipitators	Solids in the Residue Taken From This Digester per Minute
Mn, lb.	63.00	4.68
Fe, lb.	1.95	112.97
SiO_2, lb.	1.05	65.00

The ores used in testing the process came from nearly every well-known manganese-bearing area in the United States, but the procedure was the outcome of work involving primarily the siliceous manganese-bearing formation which is so very abundant in the Cuyuna district. The material used had this composition:

	Dried at 212 Deg. F., per Cent	Natural State, per Cent
Mn	15.00	13.50
Fe	27.50	24.75
SiO_2	24.56	22.10
Al_2O_3	2.50	2.25
CaO	1.00	0.90
Combined water	8.90	8.01
Moisture	....	10.00

The compositions of the manganese sinters are made whatever the product should be. The sinter may contain 70 per cent manganese; but if standard grade ferromanganese is to be manufactured from it, the inclusion of iron, at the expense of some manganese, is most desirable. Although the objective in experimenting was only to obtain a high-manganese sinter, the analyses were like the following:

	Per Cent
Mn	67.31
Fe	4.83
SiO_2	2.67
P	0.012
Al_2O_3	0.35
MgO	0.16
C	0.235

In making ferro, about one unit of iron is required for each eight units of manganese. The inclusion of 7 per cent of iron in the manganese sinter to be made will conserve this iron, which, being non-magnetic, would otherwise be lost in the tailing. It will also permit the necessary silica for the blast furnace operation to be obtained, as now, as low-grade siliceous iron ore, which is the cheapest and most desirable form possible. For these reasons the composition of the sinter is made as follows:

	Per Cent
Mn	63.58
Fe	7.06
SiO_2, etc.	2.00
P	Less than 0.02

If we have an ore containing 13.50 per cent manganese natural and have a recovery of virtually 92 per cent for the manganese hydrate, 5.199 tons of crude ore will be required to make one ton of manganese sinter. For every such ton, 1.5254 tons of iron concentrate is made as a byproduct, analyzing about 58 per cent iron and 2.57 per cent manganese. In a cost set-up, credit would be taken for this byproduct, the unit value of which would vary with the conditions of the sale, but being at least 8 to 8½c. per unit of iron plus manganese.

The applicability of this process, both mechanically and chemically, is not dependent on whether the analysis of the crude ore is as shown or is of lower metallic content. Obviously, in ores much higher in manganese than 13 per cent and correspondingly lower in iron than 25 per cent, the cost per ton of sinter necessarily becomes less, all other things being equal. This process is inherently suited to highly siliceous material. One can say that the lower the iron and the higher the silica, the better. An important feature is that the phosphorus is virtually eliminated in the treatment.

A question may be asked regarding an adequate reserve of crude material. In a paper I presented before the American Institute of Mining and Metallurgical Engineers in 1925, describing the Cuyuna manganiferous iron ores, I stated that a vast amount of manganiferous formation existed which contained more manganese than the ores that were being produced and shipped, but was not usable because of its high silica. It was presented as a potential reserve, but dependent upon the development of some suitable process of treatment. Any estimate of such material runs into very large figures. The reason for this is that we now deal with the formation which is for other ores the host or parent rock and is, therefore, limited in tonnage only by conditions pertaining to ability to remove it economically, rather than limited by analysis. Because of the excess of ammonium sulphate always present, the Bradley process is adaptable to nominal variations in the composition of the crude material.

A lowering of several per cent in the manganese content, and a raising of the silica content, would not affect the plant operation, but it would cause increases in tonnage estimates made of the crude ore. This material would be mined cheaply from open pits, and no grading of ore is involved. The passage of the ore through the plant is not regulated for small variations in the manganese content, or iron or silica. If regulation is needed, it would be in the speed of the pump for maintaining density of pulp sent to filters and not to regulate leaching. The grade of the crude ore to be used will eventually be fixed by the material that may be readily available, and by what material is cheapest to obtain.

Process Not Limited to Cuyuna Ores

The process is applicable to low-grade manganiferous ores situated in other parts of the United States, provided the oxide minerals of manganese constitute the components of the ore. Basic slag containing 8 to 9 per cent metallic manganese has also been used and 85 per cent of the manganese was recovered.

If the manganese sinter described is used for making 80 per cent ferromanganese, the following proportions of materials would be required. The iron ore prescribed is assumed to be cheap high-silica ore, and it is used chiefly for the purpose of controlling the composition of the slag.

Materials Used in Making an 80 Per Cent Ferromanganese

Sinter, gross tons	1.534
Iron ore, gross tons	0.018
Limestone, gross tons	0.388
Coke, net tons	2.000

The Cuyuna ore described required 5.119 tons of crude ore to make one ton of manganese sinter, and for each such ton of sinter 1.5254 tons of iron ore sinter and 1.345 tons of waste resulted. Production from the plant designed is doubled by doubling only the ore-reduction furnace unit. Mr. Boynton has estimated that in a run of 24 hours, the consumption of blast furnace gas would be 7,347,787 cu.ft. for reducing the ore and 3,973,200 cu.ft. as fuel for steam for evaporation and miscellaneous purposes. The fresh ammonium sulphate requirement per day is estimated at 967 lb., water requirement at 367,850 gal., and electric current at 9331.2 kw.-hr.

As to labor, the number of men required to operate the machinery described in the several steps, exclusive of those needed to operate a sintering plant, is estimated at ten, or less, per shift. Mechanics, electricians and common labor may be added to whatever extent circumstances may require from time to time. A chemist would be needed on every shift.

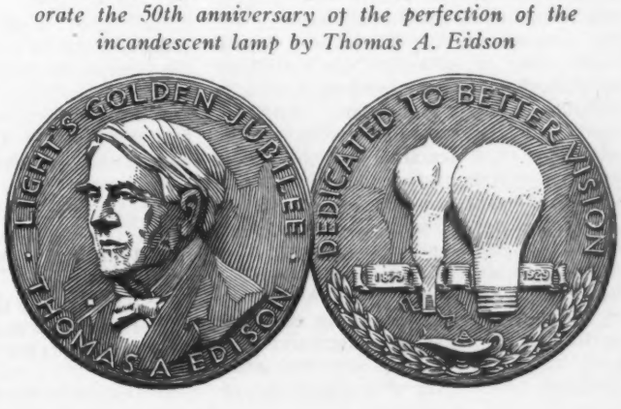
Detail of Building Construction

A building designed to house the plant would consist of two rectangular sections placed end to end. The one section, housing principally the furnaces, would be made of structural steel sheathed with corrugated iron, and would measure 140 ft. long, 45 ft. wide, and 75 ft. high (three stories). The other section, housing principally the filters, thickeners, driers and magnetic concentrator, would be made of wood and some prepared covering material, and measure 220 ft. long, 80 ft. wide, and 30 ft. high (one story). At the outside end of the first section would be a tower, 20 ft. square and 52 ft. high, to house the screens and crusher. At the outside end of the second section would be a 20x80 ft. addition with walls made of concrete, to serve as a storage bin for the manganese hydrate. These buildings are exclusive of the structure which would be required to house the sintering unit. To double the output of the plant would require the addition of another reducing unit, which is taken into account in the building design prepared by the engineers.

Medallion to Commemorate Anniversary of the Incandescent Lamp

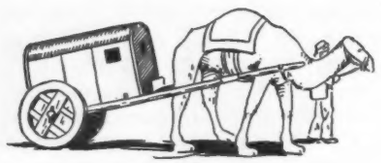
THE medallion designed by Franklin Booth, and adopted as the official insignia to commemorate the 50th anniversary of the perfection of the incandescent lamp by Thomas A. Edison, is shown herewith. One side of the medallion shows the head of Edison, to whom a fitting tribute will be paid by a series of celebrations, culminating on Oct. 21, 1929, in a great festival of light, and bears the words "Light's Golden Jubilee, Thomas A. Edison." The other side of the medallion shows the progress of the electric lamp from its invention, 50 years ago, by Thomas A. Edison, to the perfected type of today, and bears the words, "Dedicated to Better Vision." By this is meant not only better vision as regards sight, but also the sort of vision that enabled Thomas A. Edison to succeed in spite of difficulties and obstacles and pursue to a triumphant climax the inventions that result in untold blessings to all peoples today.

Medallion adopted as the official insignia to commemorate the 50th anniversary of the perfection of the incandescent lamp by Thomas A. Eidson



MINE, SHOP, AND PLANT

INTERPRETING TO THE OPERATOR THE SERVICE AND POLICIES OF THE MANUFACTURER, AND TO THE MANUFACTURER THE PRACTICE AND NEEDS OF THE OPERATOR



It is no use talking lubrication to the driver of a camel cart—or to his brethren

Why Take Lubrication Seriously?

ROLLER BEARINGS would improve a Mongolian camel cart, as would the lubrication of its squeaky wooden wheels. But the Mongol driver has never heard of either. No driver of a camel cart would take either suggestion seriously.

Outside of the Gobi Desert and a few other similarly isolated places, few could plead today that they had not heard of the importance of lubrication. The average man knows something of it because he runs a motor car and various household appliances to boot. The average mine operator is well aware that to offer such an alibi would bring a flock of oil salesmen upon him from all directions. Everyone knows something of lubrication, but not everyone has given it sufficient study to take it seriously.

How important a matter is lubrication, after all?

Everyone who has to do with machinery should know that where two metal surfaces are in rubbing or sliding contact, a film of lubricant must be introduced between them to keep them from wearing on each other. The designer knows it, and he provides or should provide the means for bringing this about. The drill repairman realizes the importance of lubrication afresh every time he takes a "dry" machine apart and notes the abrasion caused by running without lubricant. Furthermore, the effect of lubrication on the efficiency of a machine can be determined by comparative tests with different lubricants.

Other factors than lubrication, however, also enter into the running of a machine, whether it be a drill or ventilating fan. On this account, some scoff at the idea of dwelling long on what particular oil or grease is used and why. Only recently a certain superintendent declared himself on this point, saying "When I see a drill almost shaking itself to pieces trying to punch a hole in this hard rock, I can't see that the lubricant used is going to make any particular difference." This man, it happens, is not paying much attention to lubrication. He could quickly disabuse himself of his idea if he would make a few tests with different lubricants. Lubrication is not the whole answer to the proper running of a drill, but it counts considerably.

By way of dismissing a subject to which they have given little study, some others say, "It isn't lubrication so much as the lack of lubrication that counts." Such hairsplitting is really meaningless. All lubrication trouble reduces to a lack of proper lubrication. If the phrase means anything, it is that "any lubricant will lubricate," a statement that is altogether wrong. Those who hold this view seem to have reduced lubrication to a sort of superstition. They go through a certain set procedure, and then think that everything should run all right, although they can't tell why. They remind one of the man of Irvin Cobb's story, who always arranged the cushions of his motor boat in a certain way, and yelled "Hell!" down the gasoline tank, as part of the routine procedure of starting up the engine.

Although some lubricants can be used with varying results on several different machines, giving poorer results on some than on others, yet passably good at the worst, they may prove utterly worthless under certain conditions or on certain other machines. Use of the wrong lubricant simply results in improper lubrication, or possibly none at all.

Money Talks Here as Elsewhere

The best reason for giving lubrication serious study is found when we reduce it to dollars and cents. In such terms its comparative importance may be readily understood. Proper lubrication reflects itself in cost of maintenance of the equipment lubricated, as well as in economy in use of lubricant. By "proper" lubrication is meant adequate lubrication with the correct lubricant and without needless waste of the latter.

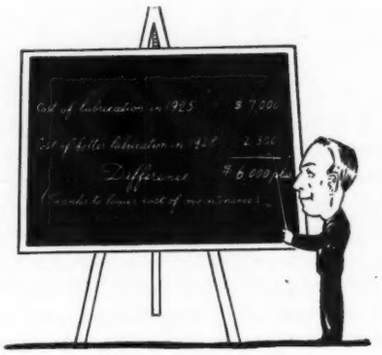
A Useless Operating Idea

The chap who thinks "any lubricant will do" tried mucilage – but the weather was too cold for it to work.

By the use of no more lubricant than necessary, the cost of lubrication per unit of tonnage handled can be kept to a minimum on the monthly cost sheet. Where the tonnage handled is large, and the monthly outlay for lubricants considerable, the saving to be made may likewise be large if the matter has not already been taken in hand. No better way of settling an argument over the value of a study of lubrication can be found than to refer it to the monthly cost sheet. Lack of such cost accounting often simply serves to cover a bad condition.

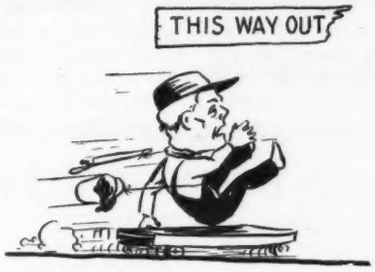
Some Facts on Cost Cutting

Most companies today are regarding lubrication seriously—the larger ones at least, where the saving to be made is greatest. Some have already done excellent work in reducing costs in this respect. A certain concentrator, handling about 2,200 tons of ore per day, was spending $7,000 to $8,000 a year on lubricants only a few years ago. Today its lubrication bill amounts to $2,700 a year and it is getting better lubrication. The difference between $7,000 and $2,700 is $4,300—an appreciable amount—but the actual saving is much larger because of the reduction in maintenance expense, attributable to better lubrication, although something that cannot readily be estimated. Of significance also is the fact that the superintendent in charge, who gives the matter his personal attention, does not hesitate to buy the most expensive lubricant he can get, if by so doing he can lower his unit cost. It is the latter that counts.



A problem in subtraction—one of those cases where two from four leaves three or possibly more

Less than two years ago the same



The oiler is no longer as prominent a member of mill society as he used to be. They have put rollers under him and roller bearings under pretty near everything else in the plant

operator was using 25 lb. of grease per day on a certain crusher. By metering the lubricant and using pressure lubrication, he cut this amount to 3 lb. per shift in the first month and has since reduced it steadily month by month, until in January of this year, a normal month as regards production, it was only 1.14 lb. per shift. The daily record which is posted in the mill shows not only the amount used per crusher per shift but also the number of pounds per crusherman. By thus pitting the three crusher men against one another, the superintendent causes them to take an interest in lubricating their machines.

Another plant, one of large capacity, is holding its monthly cost of lubrication in the neighborhood of $4.50 per 1,000 tons milled, which is considerably less than the corresponding figure 24 months ago. It proposes to lower this figure still further in the near future by adopting anti-friction bearings wherever practicable. Not only will this change greatly lessen the amount of lubricant used, but it will afford a great saving in labor expense by eliminating most of the oilers now employed.

Last year, hoist lubrication cost another large company $6.28 per month per 1,000 tons milled, for oil, grease and supplies, including hoist house, idler tower, and headframe. In 1927, when less attention was paid to such matters, this item was $11.29. Its compressor-plant lubrication cost for oil, grease, and waste in 1928 was 9c. per million cubic feet of air compressed, against 13.3c. the year before. Likewise, its pumping-plant lubrication cost for oil, grease, and waste showed an appreciable decrease from 18c. per 1,000 gal. of water pumped in 1927 to 16c. in 1928.

Common Sense Got These Results

These improved costs were not the result of chance, but followed directly on the installation of circulating systems and the use of better methods of applying the lubricants.

Other examples of the economies wrought by increased attention to lubrication in these and other plants might be cited. Those given, however, will suffice to show that it is worthy of the attention it is receiving.

When the Mine Water Eats the Equipment

WHAT would the average mine operator do about it if he had a mine water that contained the following impurities:

	Grains per U. S. Gallon
Insoluble silica	1.29
Insoluble iron oxide	0.74
Silica dissolved	0.19
Chloride of copper	0.26
Chloride of zinc	1.69
Magnesium chloride	5.10
Sodium chloride (pure salt)	109.37
Potassium chloride	4.31
Calcium chloride	182.87
Calcium sulphate	3.23
Calcium carbonate	14.46
Combined water, organic matter, and other materials	63.00

The foregoing analysis represents the water that a certain large mining company has in the lower levels of its workings. The water is highly corrosive. By experimenting the company has devised the following practice to protect equipment from its action:

Some pump cylinders and pistons are bronze, but most of them porcelain covered. In general, the pumps are so outfitted that no water touches any iron or steel. Pump shafts and other parts are covered with bronze sleeves keyed to the shaft and are easily removed. The additional cost of completely protecting the standard bronze-fitted pump is about 7 per cent.

All water pipes and water columns are of galvanized iron (2 oz. per square foot); all unions, fittings, and the like are 4 oz. plus. Only flanged connections are used. Threads of the pipe do not run up to the top of the flange (see the accompanying sketch). The top edge of the flange is first welded onto the pipe. The flange face and the surface of the male and female joint are machined in the shop, and the entire fitting is galvanized, as stated above, with a 4-oz. plus coat. It is then sent underground. Pump columns using this type of material have been in service for the last ten years. No paint or compound has yet been found that will protect pipes under mining conditions so well as galvanizing.

In general, the rule is observed that no water is permitted to come into direct contact with iron or steel. When machines and pipes are installed, they are not moved, or the protection is gone. When equipment must be moved, it is first taken to surface, scrubbed with wire brushes or sand-blasted, washed in gasoline and then in a soda solution, and thoroughly dried, then regalvanized or bronze-fitted. This company has found that corrosion results whenever any mine-water salts are painted or galvanized over. There are a few exceptions such as short pump suctions. The best grade of extra-heavy iron pipe for pump suctions lasts only two weeks, and galvanized steel one week. The company finds it more economical to change pump suctions every week. Solid brass pipe corrodes very rapidly.

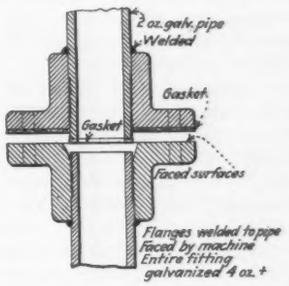
In the operation of underground locomotives, no water is permitted to drip on the plates, so that corrosion is caused mostly by moist mine air. The rust, which forms on the plates quite rapidly, is not removed, as it forms its own protection. If it is scraped off and the plates are kept clean or re-painted, they last a very short time. If left with rust coating they last five to ten years.

Rails are 40-lb., A.S.C.E., even for 2½-ton cars. They are kept as dry as possible. No water is permitted to drip on them. Most of the corrosion comes in the base of the rail, as would be expected. Rails can seldom be re-laid in wet places, and heavy ordinary steel rails are found to be cheapest.

Prompting an Investigation

Two things may compel attention to mine waters: laws prohibiting pollution of streams and excessive corrosion of equipment. Where the former do not exist, and corrosion is not strikingly bad, the matter may be neglected, and much avoidable damage to equipment will result.

Corrosion is only one of the many things not directly bearing on mining or metallurgical method or geology that



A pipe joint that defies corrosion

the metal-mine operator has to consider. So varied are his tasks by reason of these "side lines," where the staff is small, as it is at most properties, that he has good excuse if some of them go neglected. Corrosion loss, however, mounts quickly into dollars, as does poor lubrication practice, and for this reason some study should be given it to determine its proportions.

The first step of a scientific inquiry would be to analyze the water. The number of companies that apparently have no more than a vague knowledge as to the kind of water they are handling is surprising. Some evidently reason that the way equipment lasts is a fair index of the character of the water. This is plausible where no trouble has been experienced over several years. At the same time, the avoidable damage may be greater than supposed. Guesswork has little place in engineering.

COMMENT AND CRITICISM

Data Desired on Effect of Lime Concentration in Cyanidation

To the Editor of "E.&M.J.":

I have just read the monograph "Clay: its relation to ore dressing and cyanidation"[1] and find therein, on page 134, the sentence: "This rate of settlement (colloids) is hindered if an excess of lime is added." Page 975 of Taggart's "Ore Dressing," Fig. 6, gives a curve showing the relation between colloid dispersion and concentration of electrolyte. I have in mind a graduated curve or graph wherein the concentration of electrolyte, with lime as a basis, would be given in quantitative per cent and the rate of settlement in efficiency per cent. The effects would vary, of course, with the quantity of true slime, and this quantity could be defined and determined by some definition similar to that given on page 117 of the third edition of "Cyaniding Gold and Silver Ores" by Julian and Smart. To simplify calculations I would advocate disregarding the viscosity of the fluid due to the metals and chemicals in solution and work on a basis of pure water.

As the cyanide operator invariably uses lime in excess of that needed for coagulation and often to the point of solution saturation, his electrolyte concentration has passed the peak of efficiency and will be found somewhere on the down-leg of the curve.

The point in view would be to provide the operator with a fairly accurate scale whereby he may more clearly visualize the effect on thickener efficiency, of the lime concentration needed to neutralize the acidity of his ore. Do you know where data are available for the construction of such a graph or who is in position to undertake the work? I fully realize the difficulties arising from the numerous variables involved. E. G. HOWE.

Guadalajara, Jalisco, Mexico.

[Mr. Howe presents an interesting suggestion. Any pertinent information that readers may have to offer will be welcomed.—EDITOR.]

Safe and Unsafe Practice

To the Editor of "E.&M.J.":

In reply to Mr. C. S. Hurter, who claims that the No. 2 Hercules (40 per cent) powder which exploded in the hands of a prospector in Aspen in 1886 was frozen, and feels that only part of the cartridge exploded, I can positively say from experience during the early days of Leadville, from 1879 to 1884, that the miners of that time placed more confidence in the old No. 2 Hercules than they do in the DuPont powder of today, or any other dynamite that is manufactured. In those years they had no machine drills; all work was done by hand and mostly single jacking. Many of the miners would carry their supply of powder in their boots, or, in many cases, around their bodies inside their shirts. If any old-time miners are in Mr. Hurter's part of the country, they will bear me out in the above assertions.

Regarding his comment on the explosion above mentioned, when he says the entire cartridge did not explode, a very similar accident occurred early in June of this year. A copy of the Associated Press item follows:

> "Joseph Prijatu, 58 years old, an extra gang laborer for the Burlington railroad, was injured, probably fatally, today when a stick of dynamite exploded in his hand.
>
> "Prijatu, who was employed on a slag pile where the Burlington is getting out ballast, was endeavoring to insert a detonator into a stick of dynamite with a knife when the explosion occurred.
>
> "The blast tore away his left hand, lacerated his right arm and cut his head, chest, and abdomen."

After Mr. Hurter has read the report of this accident, if he is in doubt about it, I will be glad to send the original copy to him. M. J. MCCARTHY.

Canon City, Colo.

[1] *Trans.* Inst. Min. & Met., 1915-16.

Information Wanted on Roasting of Flotation Concentrate

To the Editor of "E.& M.J.":

As the roasting of flotation pyrite concentrate is a problem of growing interest in all parts of the world, I feel sure that it would be of great value to the mining industry if this matter could be reviewed by an article in *Engineering and Mining Journal.*

It is only natural that roasting such extremely fine material as flotation pyrite concentrate must involve a special technique; and, especially when the question is to roast it in the ordinary types of already existing mechanical furnaces, certain alterations or precautions can hardly be avoided.

Here in Europe the roasting of flotation pyrite concentrate is not yet accomplished anywhere on a working scale, as far as I know. In the United States, however, I am informed that several plants are using such material for the manufacture of sulphuric acid, and that the roasting has met with a fair degree of success.

If the experience from these plants could be published in an article in *Engineering and Mining Journal,* it certainly would be of benefit to many flotation plants in helping them to find an outlet for the accumulating stocks of pyrite byproduct. KJELL LUND.

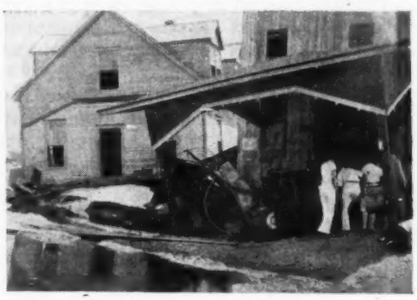
Stockholm, Sweden.

[Readers who have experiences to relate and data to publish will be doing a favor to Mr. Lund and to many others if they will come forward with the requested information—EDITOR.]

Noah Had Nothing on This

To the Editor of "E.&M.J.":

Toward the latter part of May, while servicing a new installation at Baytown, Tex., Dr. Goodwin, Ferguson and I were stranded at the plant, cut off from the mainland by a flood. The account of what took place may prove of interest as adding another chapter to the adventures of the service engineer.



Flood havoc at Lynchburg, Tex.

Friday, May 31—Water rising due to heavy rainfall and strong southeast gale from Gulf of Mexico. Men seen staking down their houses to resist flood. Left 7 p.m. with water up to radiator of car for destination four miles away. Returned 11 p.m., found water 2 ft. higher and had to detour 83 miles to return to starting point.

Saturday, June 1—Cars left on the road day before now completely submerged. About 700 ft. of main highway to Houston washed out; Missouri Pacific Railroad trestle cut to let flood out; ferry approach 7 ft. under water; and Baytown cut off from mainland, with telephone, telegraph, and mail service suspended.

Sunday, June 2—Oil tanker broke loose while loading and ran aground, blocking channel of Houston ship canal. All sorts of wreckage afloat, including parts of houses, tree trunks, and boxes. Rabbits, armadillos, and small alligators seen floating by on wreckage.

Monday, June 3—Everyone in Baytown had 12 to 15-in. alligators as pets, many being led about on ropes. San Jacinto Inn had water up to window sills of first floor. Other houses in lower part of town submerged to second story windows. Emergency telegraph lines put in commission.

Tuesday, June 4—Airplane service started to bring in butter and milk. Tugs used to carry heavy food stuffs. Airplane passenger service to Houston at $5 per person plus $2.50 taxi fare from airport to city. Mail service restored.

Wednesday, June 5—Flood receding and ferry service being resumed.

Thursday, June 6—Railroad trestle repaired and trains running. Interurban electric trolleys operating on half schedule. Highway repair under way with estimate of 20 to 30 days to complete work.

Friday, June 7—Normalcy restored. No hits, no runs, no errors.

GEORGE DARBY,
New York, N. Y. *The Dorr Company.*

Book Reviews

The Copper Country's Copper

THE COPPER DEPOSITS OF MICHIGAN. *By B. S. Butler and W. S. Burbank in collaboration with T. M. Broderick*[1], *L. C. Graton, C. D. Hohl, Charles Palache, M. J. Scholz, Alfred Wandke and R. C. Wells. Professional paper 144, U. S. Geological Survey. Pp. 238. Price $2.50.*

THIS valuable report is an admirable illustration of the good effect of co-operation, not merely between the federal government and private interests, but also among a group of scientific specialists, Hohl, for instance, contributing local knowledge; Palache, expert mineralogy; Wells, chemistry; and Graton, the study of polished sections. This latter study is for the first time applied to this region.

The work contains a detailed account of the mines and of their production and dividends. It is a pity that in such papers the general principle has been to give production in much detail but to give very little about prices, which are, of course, included in the mineral resources reports. One must remember, however, that an ore is something that can be mined at a profit, and, when studying ore deposits, one can properly consider the price as affecting the percentage of copper which could be worked profitably, the improvements in methods of mining and recovery which tend to lower that percentage, and the fluctuations in price which tend to make the variation. Yet, in this respect, the report follows the standard practices of the U. S. Geological Survey, although the report of the Champion mine and others furnish readily valuable figures as to average yearly price and yield per ton. On p. 147, however, a valuable table of yield per ton and dividends per pound is noted, which would be of even more value if it were made a function of the date and the price.

Accompanying the report is an admirable series of illustrations including a series of maps (Plates 1-14) and geological sections across the formation which are on a larger scale and much easier to read than those in Publication No. 6 of the Michigan Survey. A very valuable additional feature is a series of plates showing a longitudinal section along various lodes, and of these, Plates 39 to 41 are colored to show three grades of richness of the lode. Just what the colors mean numerically is not indicated on the plate. The line between poor and intermediate may vary from year to year. The cream of the work in this respect is in Plates 38 and 40, which give the distribution on the Calumet conglomerate and the Kearsarge Lode. For the Calumet conglomerate, not only the richness but also the thickness of the lode is given. There is also a series of plates showing drill cores. These are very good, but perhaps no better than the colored plates of Publication No. 6 so far as they go.

A very important feature of the report is the work on polished sections and the plates thereof. This is the first time that this kind of work has been applied in this district. One of the most brilliant additions to general theory is in showing that native copper and chalcopyrite occur primary in minute quantities throughout the traps. The rôle of iron oxides in the formation has been very carefully studied both with chemical analyses and in thin sections. The authors show clearly that a change from ferrous iron to ferric iron near the point of deposition of the copper is not the agent for the precipitation of the copper.

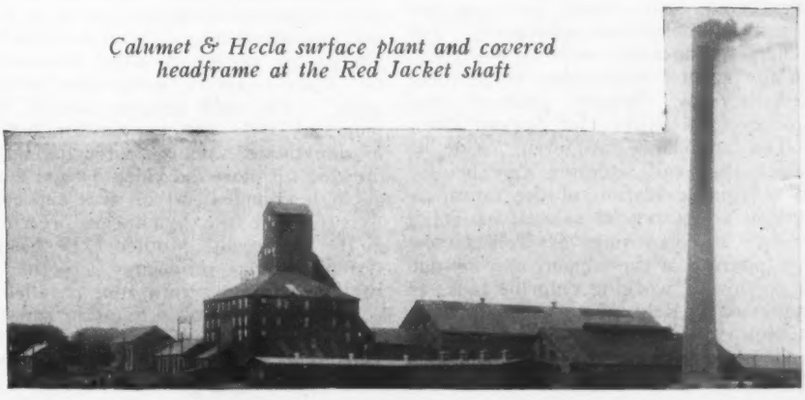
Although this report is essential to anyone who wishes to do detailed work in the district, it also has general interest with regard to the theory of ore deposits. The authors are inclined to claim a hypogene origin of the copper deposits, thinking that when they have shown that the copper was not deposited by the oxidation of the ferrous iron they have removed the chief argument for their origin by descending solutions. This does not seem to the reviewer to be the case. To explain their hypogene origin, they assume an extension of the Duluth gabbro under Lake Superior which is not known to be true. They then assume that magmatic emanations pass up the Keweenaw fault and work up the lodes, although copper is not associated with the Keweenaw fault, and they say that the movement on the Keweenaw fault probably did not begin till late Keweenawan time, and much of it occurred after the "Eastern" sandstone was deposited. "The transverse folding and faulting probably followed the Keweenaw faulting and preceded the period of mineralization." This would make the latter not earlier than the Ordovician, which is many million years after the intrusion of the gabbro. Moreover, they make little of the "chance" fact that the mine waters are quite different from those of the western hypogene copper deposits of Butte, for instance, but are much like those of the iron country (and there is a little copper in the Mesabi ores) and those of oil fields.

They also have to consider that the association of copper with black shales of the None Such Lode and not in otherwise similar structures with red shales is "fortuitous." One of the practically important features of the report is the recognition that much of the brecciation of the amygdaloids is a primary "aa" structure which has been filled in, was originally very pervious, and guided the course of the ore-depositing currents. But, as their paragenesis table shows, the copper deposition took place during this filling, which may amount to as much as 30 per cent. This occurred without any notable increase in silica, either in the amygdaloids or conglomerates, the composition of the amygdaloid not being very far from that of the vesicular basalts. It seems forced, then, to assume for the copper an origin different from that of the rest of the ordinary amygdule filling minerals.

Undoubtedly the most economically important part of the report, however, that which has induced frequent references in Boston financial papers, is the bearing of their theories on the question of shoots of copper. Fortunately they give the facts, so that it is up to anyone to see how far their conclusions are warranted.

One is puzzled to understand how, in view of the statement that "the movement on the Keweenaw fault probably did not begin till late Keweenaw time, and much of it occurred after the 'Eastern' sandstone was deposited (which is upper Cambrian), that the transverse folding and faulting probably followed the Keweenaw faulting and preceded the period of mineralization" (Plate 12), they could look for hypogene action as a source of the copper, unless they ac-

Calumet & Hecla surface plant and covered headframe at the Red Jacket shaft



[1]Broderick's papers on Zoning in Michigan Copper Deposits and Its Significance, in *Economic Geology* for March, April and May, 1929, should be considered as a supplement.

cept the Duluth gabbro or some other intrusive in the Lake Superior region as late Cambrian!

It is agreed that cross fissures and faults affect the mineralization. This is brought out clearly in the coloring of the Mohawk and Ahmeek mines in Plate 40. The barren belt cutting No. 1 Ahmeek shaft is typical of a large class of fissures in the northern end of the range which strike nearly north and throw the northeast side of the fault to the south. The richer rock is on the whole on the upper side of the fissure, the trough side. Is not this generally (though not always) true of these cross fissures? Is not the water in them generally fresher than in the tighter and more impervious parts of the formation?

As they say, fissures are found from which richness seems to secrete into the adjacent pervious beds, others from which the richness seems to be crowded away. Generally speaking, when copper is in fissures, it is only in certain horizons, as in the Central mine where it was between the Greenstone and the Kearsarge conglomerate.

The copper seems to stop at the Greenstone and to be found again only many hundred feet above in the Ashbed horizon. How this could be is difficult to see if the cross fissures were the feeders and were a deep source; and so the authors (p. 118) agree that the chief mineralization is not from that source.

Much of the treatment of impervious ground and of pervious brecciated or coalescing cellular amygdaloids and of funnelling action as guides to the copper depositing solutions should be valuable in exploration. One should remember, however, that most of this "funnelling" action will work equally well whether the circulation be up or down, and that in some respects the zoning of a "wave" of alteration may be similar whether it be by waters heating up as they work down or by waters cooling down as they work up. Wells' suggestion of dilution as a precipitant is an important addition to theory.

It is not clear how, if the copper came from below, *the freshest trap should show more copper than the altered trap and amygdaloid which did not show visible copper.* Apparently in the process of alteration and compaction of the vesicular basalts, the copper had been segregated into visible parts as the quartz and calcite are segregated. The general paragenetic order is much that of any zeolitic occurrence, e. g., those described by Hewett, Shannon and Gorges from Ritter Hot Spring, Ore.

The abundance of ferric oxide to which they call attention may be due to original oxidation of the flows, *or equivalent superficial loss of reducing gases.* Its blanching, as well as the precipitation of the copper, may be due to downward working chlorine ions, as suggested by Behrend and Berg in their "Chemische Geologie", and the general mode of occurrence that given by Lindgren. The general circulation that deposited the copper would be like that of a submerged and upturned Hawaiian island. The force driving the water down would be not merely the pressure of one atmosphere but the whole weight of superincumbent water.

ALFRED C. LANE.

THE MINERAL WEALTH OF THE BLACK HILLS. *By Joseph P. Connolly and C. C. O'Harra. Bulletin No. 16. South Dakota School of Mines, Rapid City, S. D. Pp. 418 and 64 plates. Price, 80c. plus postage.*

Had this volume appeared two years ago it would have helped materially in satisfying the popular desire for information about the Black Hills aroused by President Coolidge's visit to the district. Although the man in the street has probably forgotten by this time that this wonderful region exists, the Hills still have an interest for many who are mindful not only of their scenic beauty and their wealth of fish and game, but of their varied mineral resources as well. Credit is due the authors for having produced a time-saving volume covering the mineralogy and economic geology of the region. They have undertaken to review the mineral productivity of the district, to explain in some degree the manner in which mineral deposition has taken place, and to point out some of the possibilities of future development. Because of its completeness, Bulletin 16 will be found a very useful book. The 64 plates are principally photographs of the region.

THE MOTHER LODE SYSTEM OF CALIFORNIA. *Professional Paper 157, U. S. Geological Survey. By Adolph Knopf. U. S. Government Printing Office, Washington, D. C. Pp. 88. Price 55c.*

Dr. Knopf describes the Mother Lode belt as a long narrow strip a mile wide and 120 miles long. The early belief was that a quartz vein extends continuously from one end to the other. But as the gold deposits are not continuous and do not consist of quartz veins only, the term Mother Lode system is more appropriate. "The variety of gold deposits that occur in the Mother Lode system," says Dr. Knopf, "is very considerable, and therein lies one of the possibilities of future expansion of output, for attention has been focused too sharply on the quartz-filled fissures as the main mode of occurrence of the gold." The gold deposits are of two principal kinds—quartz veins and bodies of mineralized country rock, the latter showing far more individuality and more geologic complexity than was expected. According to the hypothesis presented in the report, the Mother Lode fissure system appears to occupy a series of auxiliary fractures in a zone parallel to a great reverse fault. Facts in support of this hypothesis are so far known only from that part of the belt extending from Plymouth to Jackson.

DEVELOPED AND UNDEVELOPED MINERAL RESOURCES OF WYOMING. *By C. S. Dietz. Bulletin XXI, 1929. Cheyenne: Wyoming Geological Survey, Pp. 194. Price $1.*

A COMPREHENSIVE SURVEY of Wyoming's mineral resources is presented by the author in this bulletin. It is in two parts, the first being devoted to metallic ores and non-metallic minerals and the second containing several papers on general economic topics. The 21 chapters of Part I cover the following substances in which the state's mineral wealth consists: Gold, silver, and platinum; copper, lead, manganese, tin, and zinc; iron ores, including hematite, titaniferous ore, chrome iron, and paint ore; radium, uranium and vanadium ores; abrasives, such as corundum, garnet, grindstone, pumice, and tripoli; sodium salts and magnesium sulphate; ceramic and road materials; natural pigments, including carbon black, asphalt and Rawlins red; miscellaneous nonmetallics including asbestos, bentonite, graphite, gypsum, limestone, mica, mineral waters, and sulphur; fertilizing minerals, including phosphates, potash and natural ammonia deposits; and, finally, coal, oil, and natural gas. The chapters on the fertilizing minerals mentioned are especially worthy of attention.

Dividing the twenty leading mineral products of the United States into four categories—namely, mineral fuels, steelmaking materials, building and structural materials, and non-ferrous metals—Mr. Dietz then points out "the superlative supremacies that Wyoming offers" within these four major industrial fields. Referring to a slogan, "Wyoming, the Pennsylvania of the West," coined some years ago, he says "Perhaps, the next work of the slogan-maker will be: 'Pennsylvania, the Wyoming of the East'."

LES RÉSERVES MONDIALES EN PHOSPHATES. *Vols. I and II. Bureau of the XIVth International Geological Congress. Madrid: Graficas Reunidas, S. A. Pp. 890.*

THIS is probably the most comprehensive series of memoirs yet brought together on the subject of phosphate. All countries that include the mineral among their resources are represented. Four languages—French, Spanish, English, and German—appear within the covers. The *raison d'être* of the collection is to be found in the decision of the last International Geological Congress to undertake a study of the world's mineral reserves. A monograph on pyrite appeared in the spring of 1927.

Following a word of introduction by C. Rubio, president of the XIVth Congress, and J. de Gorostizaga, 70 pages are devoted to summaries of reserves in the various countries. Following this section comes the papers making up the collection. "Phosphate in the United States" is contributed by George Rogers Mansfield.

Personal Notes

George W. Tower, Jr., has gone to Mexico on one of his periodical professional visits.

H. G. Ferguson, of the U. S. Geological Survey, is doing field work in the mining districts of western Nevada.

C. H. Behre, Jr., of the U. S. Geological Survey, leaves Cincinnati early in July for work near Leadville, Colo.

R. W. Thomas was appointed on July 1, 1929, manager of the Ray mines of Nevada Consolidated Copper in Arizona.

John D. Galloway, Provincial Mineralogist for British Columbia, has been elected a Fellow of the Royal Society of Canada.

Dr. **F. C. Lincoln,** professor of mining in the South Dakota School of Mines, is examining mining properties in southern California.

Hugh Rose, consulting engineer in Mexico City of Santa Gertrudis and the Mexican Corporation, will leave for London from New York on July 10.

E. G. Hill, of Pittsburgh University, has left for Montana and Idaho, where he will examine properties for Pittsburgh interests.

Dr. **B. S. Butler,** of the U. S. Geological Survey, has been working in the Alma Colorado district, during June, resuming mapping left incomplete last winter.

E. Baliol Scott, editor of *The Mining Journal,* of London, won the Captain's prize in the summer competition of the Mining and Metallurgical Golfing Society.

Edward Mosehauer, vice-president in charge of sales of the Metals Sales Corporation, sailed recently on the "Caledonia" for a vacation of about six weeks abroad.

John V. W. Reynders sailed recently on the "Olympic" for a brief business trip to England and the Continent. He expects to return to New York soon after Aug. 1.

Charles Spearman has returned to Montreal, after examining mineral properties in British Columbia for English interests. He also visited the Turner Valley oil fields.

Spencer Penrose, mine operator, of Colorado Springs, has agreed to contribute 10 per cent of whatever fund the city raises for the 1929 budget of the Colorado Association.

C. H. Smith, of Ogden, Utah, general manager of Lackawanna Mining, visited its new mill at Silverton, Colo., recently, and it is understood that operations will be resumed at an early date.

Cornelius F. Kelley, president of Anaconda Copper, has been awarded the gold medal of the Mining and Metallurgical Society of America for "Distinguished services in the expansion and stabilization of the mining industry."

Dr. **William W. Howe,** for several years a member of the faculty of Yale University, will join the chemistry department of the Colorado School of Mines, succeeding **L. D. Roberts,** resigned.

Dr. **E. S. Simpson,** government mineralogist of Western Australia, has been awarded the gold medal of the Royal Society of that state, for distinguished work in mineralogy and other branches of science in the last 31 years.

Carl O. Lindberg has resigned as president of Mineral Research Corporation, to resume his independent practice as consulting mining engineer, with headquarters in Los Angeles, as heretofore. His office will be in the Pacific Mutual Building.

Carl M. Loeb, president of American Metal, retired on June 30. His successor has not been elected as yet. Mr.

C. M. LOEB

Loeb, who will remain as a director of the company, was elected president twelve years ago and has been with the company since 1892.

A. W. Fahrenwald has been appointed dean of the Idaho School of Mines, according to an announcement by **Dr. F. J. Kelly,** president of the University of Idaho. Mr. Fahrenwald was appointed professor of metallurgy at the school last May.

E. C. Messner, clerk at Calumet & Hecla Consolidated's smelter at Hubbell for the last two years, has been appointed purchasing agent of the company to succeed the late **Frank J. Nicholas.** Before going to Hubbell, Mr. Messner was statistician for the company.

Prof. **W. G. McBride,** of the department of mining engineering of McGill University, and Mrs. McBride have sailed for London on the "Ausonia." They expect to spend a month in England and Scotland and a month on the Continent, returning to Montreal about Sept. 1.

James A. Shepard has been engaged as assistant general manager of Roan Antelope and expects to leave New York for the property about the middle of August. Both **D. D. Irwin,** general manager of Roan Antelope, and Mr. Shepard are graduates of the Phelps Dodge organization.

H. C. H. Carpenter, professor of mining at the Royal School of Mines, London, who receives a knighthood; and Sir **John Cadman,** emeritus professor of mining at the University of Birmingham, who becomes a knight commander of the order of St. Michael and St. George, were among those recently honored by King George.

Hon. **Charles McCrea,** Minister of Mines for Ontario, tendered a dinner on July 5 in the Speakers Chambers, Parliament Buildings, to **T. W. Gibson,** Deputy Minister, to mark his appointment to an advisory position after many years of service to the mining industry. Early in July, Mr. McCrea will leave Toronto on a tour of inspection of the mining areas of northern Ontario.

Douglas G. Sinclair, Ontario Inspector of Mines for the Sudbury district, has been appointed Chief Inspector of Mines for the province, in succession to **Thomas F. Sutherland,** recently promoted to the post of acting Deputy Minister of Mines. Mr. Sinclair is a graduate of the University of Toronto, and has been in the civil service for the last five years. He has been succeeded as inspector for the Sudbury district by **George S. Jarrett,** formerly connected with Hollinger Consolidated.

J. W. Sutherland, for many years recognized as one of the foremost metallurgists of Western Australia, recently retired from the position of manager of the Golden Horseshoe Estates mine, at Kalgoorlie, in that state. Mr. Sutherland was the first to adapt, on a large scale, the plate-and-frame filter press in the treatment of gold ore at the Hannans-Brownhill mill at Kalgoorlie, in 1927. He was for several years assayer of Broken Hill Proprietary, and associated with Lake View Consolidated.

OBITUARY

Carl J. Mayer, 35, superintendent of the Rico Mining & Milling Company, Rico, Colo., was killed on June 25 when he received an electrical shock and was thrown from a ladder, breaking his neck.

Charles Nicholas died at the Miami-Inspiration Hospital on June 17, as a result of injuries which he received while working in the No. 5 shaft of the Miami Copper Mine, at Miami, Ariz. Mr. Nicholas was a shift boss for the E. J. Longyear Company, which has the contract for sinking the shaft from the 1,000 level to the 1,120 level. At the time of the accident a string of 6-in. pipe was being installed in the shaft. One joint was cross threaded, and this gave way, causing the string to fall to the bottom of the shaft. The falling pipe hit Nicholas on the back, breaking several bones and causing internal injuries. He was born in 1877, in Cornwall, England. His home was at Negaunee, Mich.

NEWS OF THE WEEK

Summary

DRIVING of a 3,100-ft. adit at the Genii Mining property, near Magalia, Butte County, Calif., has apparently penetrated the "Mammoth channel." Page 31.

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Operation of the new 250-ton Hall Interstate mill of Bunker Hill & Sullivan, in Valley County, Idaho, was started in the latter part of May and has since continued steadily. Page 30.

* * *

Interest has been excited in northern Transvaal by the successful operations of Beryl Mining, which is producing emeralds. A new plant with a capacity of 200 tons daily has been ordered. Page 32.

* * *

Chief Consolidated and Mammoth Mining have ended litigation over the Grand Central boundary lines, in the Tintic district of Utah, by mutual agreement. This litigation has been in progress for about 30 years. Page 28.

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J. H. Alexander, former employee of Noranda Mines, in Quebec, has been arrested for trying to obtain information contrary to the provisions of the Criminal Code. Page 32.

* * *

Homer L. Gibson, Toronto broker, has taken an option on the property of Flowery Gold Mines, on the Comstock Lode in Nevada, which has been operating profitably on $2.50 ore. Page 28.

* * *

Lake Shore has proved high-grade ore for a length of 500 ft., on the 1,800 level of its mine at Kirkland Lake, Ont., according to official statements. Page 26.

* * *

Statements on the proposed tariff as it affects manganese, tungsten, lead, and zinc were presented to the Senate subcommittee last week. Page 27.

Hudson Bay M. & S. Preparing to Sink Main Shaft at Its Flin Flon Mine

All Underground Ore at Important Manitoba Development Will Be Hoisted Through This Unit, Which Will Be Equipped With an 850-HP. Electric Hoist of 9½-Ton Capacity

PREPARATIONS for sinking the main five-compartment shaft at the Flin Flon mine of Hudson Bay Mining & Smelting, in northern Manitoba, Canada, are now well under way. All underground tonnage will be handled through this unit, which will be equipped with a large electric Nordberg ore hoist, and a smaller hoist for handling men. On the present main level, 390 ft. deep, a crosscut has been run to a point underneath the site of the shaft, and a raise has been driven to the surface, according to R. E. Phelan, manager of the property. A steel and concrete bearing set has been put in at the surface and the shaft widened out to its final size from the surface to 70 ft. in depth.

Steel shaft timbers will be used, and these are all on the ground. At present they are being coated with a gilsonite preparation, before being installed underground. An experienced shaft-sinking crew is being collected, and the sinking equipment is being installed.

Both Nordberg hoists are so designed as to permit increasing their capacities as future conditions warrant. For the first seven years hoisting will be effected from the 1,050 level, hoisting about 3,000 tons of copper-zinc ore in seven hours' actual hoisting time. The ore hoist is arranged with single-reduction Herringbone gears and driven by an 850-hp. a.-c. motor. It will have a hoisting speed of 1,050 ft. per minute, hoisting in balance with a load of 19,000 lb. of ore, 9,500 lb. for the skip, and 4,800 lb. for the rope, or more than 33,000 lb. in all. Later, the gears will be removed, and the hoist will be connected directly with an 1,800-hp. d.-c. motor. Operating conditions will then be 3,000 tons in seven hours, lifted from a depth of 2,150 ft., and speed will then be stepped up to 2,150 ft. per minute. This will increase the rope weight to 9,000 lb., or the total load to more than 37,000 lb.

This hoist will have double drums of 10-ft. diameter and 5-ft. face. It will be equipped with a Lilly stop, and the total weight of the machine will be about 286,000 lb.

Normal hoisting speed of the man hoist, which will be equipped with a 250-hp. motor, will be 800 ft. per minute. However, the gears are designed to allow for an ultimate hoisting speed of 1,200 ft. per minute and for changing depth from 1,050 to 2,150 ft. When this change is made, the motor will be replaced by one of 400 hp.

Lake Shore Opens 500 Ft. of High-Grade Ore at Depth

DRIFTING east and west from the main crosscut on No. 2 vein at the 1,800 level of Lake Shore mine, at Kirkland Lake, Ont., has opened up continuous ore averaging between $30 and $35 in gold per ton across a drift width of 8 ft. for a total distance of 500 ft., with both faces continuing in ore. This information was obtained by the *E. & M. J.* correspondent from official sources. The 1,800 level is the lowest working level in the mine. As yet no crosscuts have been driven across the vein, and consequently the actual width of the ore has not been determined.

No. 3 shaft has been completed to a depth of 2,000 ft. and a station is being cut at this horizon preparatory to crosscutting through the ore zone and raising on No. 1 shaft to the 1,600 level. In another month or six weeks sinking will be continued on No. 3 shaft.

Preparations are going forward rapidly for increasing the tonnage of the mill, and new filtering equipment is being installed.

Start Cleaning Out Tunnel Near Dayton, Nev.

Work of cleaning out the Boyle tunnel at the Como property, near Dayton, Nev., which was taken over by Charles Oster, of New York, and St. Joe Consolidated, has started. St. Joe Consolidated also owns a property in the Coeur d'Alene district of Idaho. A plant is being built at the portal of the tunnel, which is 4,000 ft. long.

Controversy Continues in Metal Tariff Hearings

MANGANESE ore constituted one of the most controversial items on the metal tariff schedule during the hearings on June 26-27 before the Senate subcommittee comprising Senators Reed, chairman; Smoot and Edge, Republicans, and King and Barkley, Democrats. With the steel industry clamoring for its return to the free list, and with the domestic producers pleading for an increase from 1 to 1½c. per pound Mn on ores having more than 30 per cent metallic manganese, and a duty of 1c. on ore containing 20 to 30 per cent, and a duty of ½c. on 10 to 20 per cent ore, that the Senate Finance Committee will disturb the present tariff is unlikely.

A duty of $3 per ton on pig iron was advocated by F. B. Richards, representing the Hanna Furnace Company, of Cleveland, Ohio. The rate carried in the 1922 act was 75c. and the Ways and Means Committee incorporated a rate of $1.125 in its bill. This was the rate applied by Presidential proclamation in March, 1927. Mr. Richards stated that the importation of pig iron along the Atlantic seaboard represents 91 per cent of total imports and is the equivalent of 23 per cent of the productive capacity of merchant blast furnaces in eastern Pennsylvania, New York, and New England.

John W. Logan, of the Allen Wood Steel Company, Conshohocken, Pa., also argued in support of the $3 duty on pig iron. He contended that the protective duties on the products made from pig iron (steel in its various forms, cast iron pipe, and other products) are now as high as or higher than those applying when pig iron had a duty of $2.50.

Inclusion of hammered, rolled, and milled scale in Paragraph 301, with wrought and cast scrap iron and scrap steel, was requested by V. R. Lansingh, of New York City, representing tungsten and molybdenum refiners. Under this classification, scale would pay, in addition to the duty of 75c. per ton, an additional duty of 72c. per pound on the tungsten content in excess of 1/10 of 1 per cent. Mr. Lansingh asked for duty of 60c. per pound on tungsten content and 50 per cent ad valorem on tungsten metal and tungsten carbide powder under Paragraph 302 (g), and for the transfer of tungstic acid from that paragraph to Paragraph 92 of the chemical schedule with vanadic acid.

A 50 per cent increase in the tariff on tungsten ore and metal, to include alloys, metal scrap and all materials containing tungsten, was advocated by George E. Collins, of Rico, Colo., chairman of a committee appointed by the state legislature. The undeveloped resources of this country are sufficient, he said, to supply its entire requirements, but it is not possible in the long run to produce tungsten profitably without sufficient tariff protection to keep out the alluvial tungsten from China.

An increase of 33⅓ per cent in the present tariff rates on lead ores, lead products and metallic lead was urged by Mr. Collins on behalf of Colorado producers. With respect to zinc-bearing ores, Mr. Collins declared that they should bear a uniform rate of 1½c. per pound on the zinc recovered therefrom, irrespective of the zinc percentage. He argued that there is no valid reason for the existing differentials in the zinc ore duties. The present tariff does not apply the full rate of 1½c. per pound until a zinc percentage of 25 per cent is reached, which means, he said, that only exceptionally high-grade ore pays this rate.

No duty that Congress can place on tungsten ore will increase domestic production, declared former Senator C. S. Thomas, of Colorado, representing the David Taylor Company, of Denver. Senator Thomas objected to the increase from 45 to 50c. per pound in the duty on the metallic tungsten content of tungsten ore and concentrates provided by Paragraph 302(c). He also opposed the additional duty levied on scrap by Paragraph 301, of 72c. per pound on the tungsten content in excess of 1/10 of 1 per cent.

Mr. Collins and Nelson Franklin, of Washington, representing tungsten producers, argued that the duty of 50c. per ton on the metallic content of tungsten ore is justified by the difference in production costs in China and the United States.

Above—The entrance to the Mascotte tunnel, of Ohio Copper, through which Bingham Mines ore from the properties in Bingham Canyon is handled. Below—The headframe and power house of Eagle & Blue Bell, in the Tintic district.

Merger With Bingham Mines Adds Large Area to U. S. Smelting's Holdings in Utah

HOLDINGS of U. S. Smelting, Refining & Mining in the State of Utah have been greatly increased by the acquisition of the properties of Bingham Mines, totaling 3,500 acres, as announced in our issue of June 22. In the Bingham district, Bingham Mines owned 2,213 acres of land adjoining the United States mine, including the Dalton & Lark, Commercial, Yosemite, Montana Bingham, Utah Copper, and Watson claims. At Tintic, the company either owns, controls, or has a substantial interest in the Eagle & Blue Bell, Victoria, Tenora, Harrington, and American Star properties.

Acquisition of the properties at Bingham will give U. S. Smelting two deep entries into its mine, the Butterfield tunnel of Park Bingham and the Mascotte tunnel of Ohio Copper. Bingham Mines has been using the Mascotte tunnel, which is 15,000 ft. long and equipped for electric haulage. To reach the United States mine, it will have to be extended about 7,000 or 8,000 ft. The Butterfield tunnel intersects the United States workings about 1,600 ft. below the surface, and continuation of the Mascotte tunnel would cut the workings 450 ft. deeper, affording more economical transportation.

Finally End Litigation Over Tintic District Claims

LITIGATION of thirty years' standing between two Tintic district companies, Chief Consolidated Mining, and Mammoth Mining, has been terminated by an agreement providing for vertical sidelines. Each company is to pay its own costs and neither recovers damages. The effect of this agreement was a dismissal of a petition for rehearing in the United States Supreme Court.

Last November, the United States Circuit Court of Appeals handed down a decision in which it held the Mammoth liable for an accounting for ores taken from the adjoining properties of the Chief Consolidated. The case was begun in 1899, when Grand Central Mining sued the Mammoth for an accounting of ores taken from the Grand Central property. Later Chief Consolidated took over the property and its name was substituted as plaintiff.

Mayflower Mines Driving Tunnel at Park City

PROGRESS of the Mayflower Mines tunnel, on the east side of the Park City district, Utah, is averaging 6 ft. a day. As soon as surface work is completed, two full shifts will be employed and an average of 250 ft. a month made. A two-story bunkhouse, 60x30 ft., has been completed and the power plant connected with the lines of Utah Power & Light. A Sullivan two-drill compressor has been installed.

The new adit is being driven to furnish drainage and transportation for the Mayflower, the Park Bingham, the Park Galena, and the Star of Utah, all controlled by Charles Moore. At 2,000 ft. the Pearl fissure will be struck, from which some ore was shipped 40 years ago by the present manager, T. L. Walden; at 3,000 ft., the Glencoe fissure; at 3,600 ft., a point below the old Park Bingham workings; and at 5,000 ft., the Park Galena workings.

About 4 ft. of ore has been opened up in the diorite in the Park Galena 500 level, and a shipment has been made. The gangue is showing an increasing calcium content, indicating that the limestone contact is near.

Cut Wages of Utah Miners

Wages at silver-lead-zinc mines in the various districts of Utah have been reduced 25c. a shift, effective June 1, as a result of the failure of the lead price to stay above 7c. Wages were increased early this spring, when the lead price went above 7½c., even though no increase was necessary under the sliding-scale agreement now in effect. Wages will not be cut in the smelting plants, according to announcement. A similar decrease will probably be made in the Coeur d'Alene district, but no announcement has yet been made.

Toronto Broker Options Flowery Gold Mines

AN OPTION on the property of Flowery Gold Mines, operating south of Virginia City, Nev., has been taken by Homer L. Gibson, Toronto broker. Crosscutting the vein at several points will be undertaken to determine if the option will be exercised. Roy Hardy, mining engineer of Reno, will direct this work.

Equipment at the property includes a 150-ton cyanide mill, a surface tramway, and electric locomotives. Operations have been conducted at unusually low costs for so small a mine. Last year the company, which is owned by the Wise brothers, made a profit on ore averaging $2.45 a ton, of which 98 per cent was extracted. Mr. Hardy was formerly interested in the property, but sold his interest to Alex Wise about two years ago.

Bradley Options Claims in Minarets District

F. W. Bradley has dropped his option on the Commonwealth property, south of Reno, Nev., and has taken an option on the Nidever group of claims in the Minarets district, Madera County, Calif. The claims are at a high altitude and contain zinc, lead, and some copper showings. Some exploration was done by Myron Folsom, of San Francisco, who died several years ago.

Grass Valley Boundary Sues to Recover Mining Claims

Grass Valley Boundary Mining has filed suit against Joseph Slye to recover possession of various mining claims within the corporate limits of Grass Valley, Calif., and other claims in the district. Plaintiff alleges that defendant entered into agreement to purchase the property and to pay royalty on ore extracted. An attachment covering the property and including certain rich specimens that were exhibited some time ago has been issued, as well as a restraining order prohibiting the defendant from further mining operations.

Will Build Mill at Royal Development Property

Royal Development, operating the Trinity copper property, near Leavenworth, Wash., plans installing a mill on the unit system. The first unit will have a minimum capacity of 200 tons daily, according to James Naughten, president of the company. At this property, which comprises 114 claims and mill sites, a tunnel has been driven about 10,000 ft. to tap the St. Francis vein.

Start Drifting on Vein at Teck-Hughes' No. 25 Level

CROSSCUTTING on the No. 25 level, at a depth of 2,980 ft., of Teck-Hughes Gold, at Kirkland Lake, Ont., was stopped last week 300 ft. south of the shaft, after having intersected the main ore zone for a width of 80 ft. Several promising sections were intersected in this zone, and exploration by a footwall drift has been started east of the crosscut. Crosscuting south from the shaft on the No. 21 level has also been started, and the main ore zone should be reached in a few weeks. At the No. 20 level, drifting east and west has been in ore for 100 ft. At this depth the ore zone is apparently narrower than it is on the No. 25 level.

Explosion at Noranda Coal Plant Closes Smelter

THE smelter at Noranda Mines, in the Rouyn district of Quebec, closed down temporarily on June 28 as a result of an explosion, followed by a fire, which occurred in the coal-pulverizing plant at an early hour that morning. The cause of the explosion is not definitely known. Only two men were working in the plant at the time, and they escaped with slight injuries. The coal-pulverizing plant is adjacent to the main smelter building and has a capacity of about 100 tons of coal. About 50 tons of coal was in the plant when the explosion occurred.

Officials stated in conversation with our correspondent, that the plant would probably be closed down for three days, after which operations would be resumed in part. In spite of the interruption, the value of the June production of the Noranda smelter was the highest since the plant started operations.

Lease Shamrock Mill

The mill of Shamrock Mines at Ione, Nye County, Nev., has been leased to E. L. Burney, who is planning to use the plant for concentrating low-grade cinnabar ores. A Gould rotary furnace will be installed. Development of Shamrock Mines, owning several old properties in the district, has been financed by Salt Lake men. Rental from the mill, amounting yearly to 5 per cent of its cost, will allow the company to continue driving its tunnel to connect with the Indianapolis shaft.

Deepen Panther Mines Shaft

Deepening of the shaft of Panther Mines, 40 miles north of Montello, Nev., from the 900 to the 1,100 level, is now under way. Ore is being stoped on the 700, 800, and 900 levels, and shipments of concentrate are being made to Salt Lake City smelters. The oreshoot has been opened for a length of 240 ft.

West Coast engineers gather mid the bosky dells and sylvan splendors of the Sierras

California Sections Meet Amid Giant Sequoia Trees in the Sierra

By George J. Young,
Associate Editor

GIANT FOREST is at an elevation of 6,000 ft. or more in the Sequoia National Park, in California. It is reached by an excellent highway, which switchbacks about the steep slopes of a high ridge that broadens and flattens above an altitude of 5,500 ft. On this ridge are the great sequoias and Giant Forest Lodge, where the Southern California and San Francisco sections of the A.I.M.E. held their third annual get-together on June 21-23, 1929. Most of the 80 members and their wives who attended motored to the Lodge. Distinguished members were F. W. Bradley, president of the Institute, and L. D. Ricketts, past president.

Colonel John R. White, superintendent of the park, greeted the members and discussed the important places of interest. A general scattering about the park followed. In the late afternoon many ascended the steep face of Moro Rock by short stairways. On the narrow top, the Kaweah River, several thousand feet below; the San Joaquin Valley, and the Great Western Divide could be seen. Distant ragged peaks, snow streaked, cut off the view to the east and heat haze limited the downward view to the western valley. President and Mrs. Bradley, as well as L. D. Ricketts, sauntered along this high point, as completely at home as if they had mountaineered all their lives. The view was inspiring. The day was perfect. Few members failed to follow their president.

H. Norton Johnson, pinch hitter for both sections, presided at the programs. James G. Parmelee read extracts of letters from those who could not attend, but who felt that the occasion was of more than ordinary interest. E. A. Hersam, chairman of the San Francisco section, informed the members of arrangements for the Institute's meeting in California in October and the trip to Japan. Glenn Robertson, chairman of the Southern California section, spoke of the activities of his section. Mrs. Parmelee made a weather-beaten piano thrill, and Mrs. A. Anderson sang exquisitely. President Bradley vividly recounted his meetings with the various sections of the Institute when he visited them. He commented upon the loyalty and interest of the Institute's members.

Then followed a day in the forest, a visit to the wonderful General Sherman tree (the largest in the world) and a walk by trail to Crescent Meadow, where everyone picnicked and where there was no telephone, no radio, and no hint of the busy civilization from which all had temporarily fled.

The ladies of the auxiliary arranged the Saturday night program. Mrs. James G. Parmelee tactfully engineered the meeting. Mrs. P. R. Bradley spoke for the San Francisco section and Mrs. S. L. Gillan for the Southern California section. Mrs. A. Anderson entertained with her delightful songs. Mrs. F. W. Bradley gave interesting sidelights of her trip with her husband and urged the members present to make the trip to Japan. P. R. Bradley, in introducing L. D. Ricketts, alleged that Dr. Ricketts had really taken advantage of the meeting so that he could ask the park authorities for some of the big trees for shaft timbers. Mr. Ricketts just smiled and then launched forth on the subject of the amazing changes in the industry, mentioning the growth of milling plants in the last 30 years from 400 tons to 16,000 tons per day, and still larger in some instances. He commented on the increase in the workman's output, his increased remuneration, and his added purchasing power as a result of the increase in the size of mechanical units and the increased mechanization of the industry. He compared American with European conditions. Although there is a great awakening in Europe, economic changes will be attended with great difficulties, Dr. Ricketts believes. In time, the mining development in Africa will help out, but it is a pity that more people cannot be transferred from Europe to Africa. Referring to our own country, he said that we must continue present progress by introducing more mechanical appliances and larger and larger operating units.

A mental contest involving the recording of the names of those present closed the meeting and was won by F. W. Bradley, with Mrs. Bradley a close second. The younger members finished the evening at an open-air dance; others gathered and chatted by the camp fire, and still others sought their cabins. Sunday saw a general exodus down the mountain to the hot valley and homeward. All will remember the story of the "kind word": "Don't eat them eggs."

Burma Corporation Cuts Ore Twice on No. 9 Level

CROSSCUTTING east from the north drive on the No. 9 level of the Shan Lode, at the Bawdwin mine, of Burma Corporation, in Burma, has cut ore twice. The crosscut is 379 ft. north of the shaft. After 35 ft. of crosscutting, ore was found for a width of 2½ ft., averaging 20 oz. of silver per ton, 51 per cent lead, 9.8 per cent zinc, and 0.2 per cent copper, according to D. Anderson, London secretary of the company. At a point 64 ft. from the crosscut, another orebody, 20 ft. wide, was struck, which averaged more than 40 oz. of silver per ton, 51.4 per cent lead, 10.8 per cent zinc, and 0.1 per cent copper. Crosscutting to the Shan lode at a point 259 ft. north of the shaft on the No. 9 level disclosed 16½ ft. of ore, assaying 38 oz. of silver to the ton, 42 per cent lead, 18 per cent zinc, and 0.16 per cent copper.

During the first three months of the year, the Marmion shaft was sunk to a total of 1,166 ft., according to the quarterly report of the company. The excavation of the ore pocket below No. 8 level was completed, and 1,357 cu.ft. of concreting placed therein.

Walker Brothers Cons. Resumes Development Work

Development work has been resumed at the Walker Brothers Consolidated Copper property, near Walker Mining, Plumas County, Calif. A portable compressor will be installed. J. R. Walker, president of Walker Mining, staked the Walker Brothers property about 25 years ago. No work has been done for the last ten years, however. The group of claims is one mile wide and two miles long. Mineralization occurs in a quartz zone in highly silicified rocks of Lower Carboniferous age. A granodiorite uplift between the Walker mine and the Walker Brothers' property gives the latter property a west dip and the former an east dip.

Hall Interstate Mill Now Producing Regularly

PRODUCTION from the new Hall Interstate mill of Bunker Hill & Sullivan was started at the end of May and has been continued steadily since. This plant was built by B. H. & S. at Bernard, Deadwood Basin, Valley County, Idaho, and has a capacity of 250 tons of silver-lead-zinc ore daily. Treatment is by selective flotation. Lead concentrate is shipped to the company's smelter at Kellogg, Idaho, and the zinc concentrate is sent to the Sullivan Mining plant, near Kellogg. Gold and copper, as well as about 100 oz. of silver per ton, are contained in the lead concentrate. Hydro-electric power is obtained from Stratton Creek, across the valley, and additional power is being developed on the Deadwood River, adjacent to the portal of the main tunnel.

Cascade, 52 miles from the mine, is the nearest railroad station. A forestry road connects the mine with the railroad. Trucks are used for hauling over this road from June 15 to Oct. 15. The rest of the year communication is by dog teams.

The Hall Interstate and Lost Pilgrim properties were taken over by Bunker Hill & Sullivan about three years ago. Early development of these properties was accomplished mainly by Sumner Hall, Joe Goecke and other well-known pioneers of central Idaho. The immediate area was well known in the early days as quite an important placer mining section, and it also figures in Idaho history as the scene of General Bernard's campaign against the Sheepeater Indians, an event commemorated in naming Bernard Mountain overlooking the mine. The formation of the district is largely granitic, with ancient sediments altered to gray schists in which the ore is found. The surface showing on the Hall Interstate property is particularly interesting, disclosing large amounts of galena and zinc blende, there being little or no oxidation or secondary enrichment because of surface conditions. The main operating tunnel is a short distance above the floor of the valley. More than 10,000 ft. of mine openings have been driven, reaching from the tunnel level to the surface discovery. On account of fault fissures, which traverse the ore-bearing area, and the large amount of water to be drained, mining conditions are difficult.

The new Hall Interstate silver-lead-zinc mine of Bunker Hill & Sullivan, at Bernard, Valley County, Idaho, which started production in May

Prospector Wins Suit Over Big Missouri Purchase

ONE-THIRD of the money obtained from the sale of the Big Missouri mine in the Portland Canal district of British Columbia, amounting to $100,000, has been awarded to William F. Harris, a prospector of Port Angeles, Wash., by Chief Justice Morrison, in the Supreme Court of British Columbia. Mr. Harris sued his former partners, Daniel and the late Andrew Lindborg, of Hyder, Alaska, for his share in profits from the sale of the mine, and, though there were no writings in connection with the partnership, he was able to establish its existence. The most damaging evidence against the Lindborgs was that Daniel Lindborg was present in court, but did not take the stand either to refute or explain the evidence brought against him.

The Big Missouri mine was optioned to the Big Missouri Mining Company, of Tacoma, for $250,000. After developing it for more than a year and paying $75,000 on the option, the company sought and obtained the co-operation of the Consolidated Mining & Smelting Company of Canada to complete the deal, and the Buena Vista Mining Company, of which Consolidated owns 53 per cent and Big Missouri the remainder, was formed to take the option over. The property was bonded four times before it was sold, and on each occasion a substantial payment was made; these payments account for the difference between sale price for the mine and total amount obtained from it. Mr. Harris is 76 years old.

Report New Strike in Old Camp Bird Mine

A strike of high-grade gold ore is reported in the famous old Camp Bird mine, near Ouray, Colo., now being operated by King Lease, Inc. The new ore was struck in a stope above the No. 3 level, east and west of the main crosscut. On the No. 2 level above, ore of similar grade is reported. Shipments are being made to the Golden Cycle mill, at Colorado Springs, and the Arkansas Valley smelter of American Smelting & Refining, at Leadville. About 22 men are now employed by the leasing company. Joseph King is general manager.

Gas From Fire Area at Bisbee Causes Trouble

Gas from an old fire area in the Sacramento mine of the Copper Queen branch of Phelps Dodge, at Bisbee, Ariz., escaped on June 20 and necessitated removing 450 men at work in the vicinity until bulkheads and brattices could be built. The fire is on the 1,400 level of the mine and has been burning for several years.

New Find Made Near Beaverdell, B. C.

E. Nordman, general manager for Beaver Silver Mines, which owns a group of claims on Wallace Mountain, near Beaverdell, B. C., on the Kettle Valley Railway, has made an interesting find. Wallace Mountain has been noted for its comparatively narrow and frequently faulted veins of high-grade silver ore, all the ore from the district having been shipped directly without preliminary dressing. The new discovery, which is about 800 ft. from the old workings, is a wide belt of mineralization, at least 20 ft. of which is of milling grade. A trench, 5 to 15 ft. deep, has been cut across 60 ft. of mineralized rock.

Equip Castle Peak Mine With Quicksilver Furnace

Installation of a 40-ft. Gould rotary quicksilver furnace at the Castle Peak mine, north of Virginia City, Nev., is being completed under the direction of Roy N. Hill, of the engineering staff of H. W. Gould & Company. Operation is expected to start by Aug. 1.

Mr. Hill states that the new plant at the Oat Hill property of Acme Mining & Milling will be ready about July 20. Production from the company's La Joya mine was 81 flasks of quicksilver during May.

3,100-Ft. Adit at Magalia Reported to Have Penetrated Buried River Channel

INTEREST has been aroused by the recent exploratory work of the Genii Mining Company, operating near Magalia, Butte County, Calif. An adit, 3,100 ft. long, has apparently succeeded in penetrating to the "Mammoth Channel." Geologists believe that the gravel of this old river bed should contain gold in paying quantities.

The region north and northwesterly of Magalia has been prospected for old river channels and some important segments have been found and worked. As in other localities, there appear to be several channels, most of them lava capped and hidden. Lindgren, in Professional Paper 73 on "The Tertiary Gravels of the Sierra Nevada of California," maps the old channels tentatively, indicating the Little Magalia Channel and the probable course of the "Magalia Channels," presumably the main trunk. The last named is now called the "Mammoth Channel," at which the new exploration is directed.

Respecting this channel, Lindgren records three attempts to work it: the Mammoth shaft sunk to 100 ft., west of Magalia; near by the Ethel tunnel driven at an elevation of 1,300 ft. on the west side of Middle Butte Creek (no satisfactory results were reported at either place); and the Parry incline about 2 miles northeast of Magalia on the west side of Little West Branch. The incline started at an elevation of about 1,860 ft. and was sunk to the west at an angle of 22 deg., reaching a vertical depth of 260 ft., the elevation of the "supposed bedrock of the channel" being estimated to be 1,630 ft. Lindgren states that a drift, 500 ft. long, was run, from which several 30- to 60-ft. raises were extended, showing that the channel was filled with coarse sand and large boulders with little pay gravel on the bedrock. The quantity of water is given as 26 to 28 miners' inches. He states further: "Below this point the Magalia (Mammoth) Channel continued in a narrow, canon-like valley, widening to a more open one at Centerville. Although it traverses auriferous territory throughout, the results at the two places where it has been opened show that reliance cannot be placed on its paying character. However, it should contain pay gravel, at least from the Parry mine downward toward the old Mammoth shaft."

The present effort to penetrate the deeply buried Mammoth Channel consists of an adit driven at an approximate elevation of 1,600 ft. on the west side of the West Branch of the Feather River, south of the bridge across the river and about northwest of Saw Mill Peak. It is driven northwesterly and cuts the channel about 1½ miles southwest of the Parry mine. The adit has reached a length of about 3,100 ft. It is entirely in bedrock except where caved ground has exposed what is apparently the channel. A heavy flow of water has been struck and meanwhile the caved portion at the end of the adit is being recovered. Until the channel can be explored its mining possibilities will remain unknown.

The property upon which the adit is driven is estimated to control 1¼ miles of the Mammoth Channel. It was owned by Cohan and Gooday, merchants of Magalia, for several years and, although never operated, remained in their possession until their death. T. W. Simmons bought it from their estates and control was subsequently acqired by Genii Mining, which equipped the property, constructed a road between the highway and the river and drove the present adit. The adit is 6x8 ft. over-all and is on a grade of ¼ in. per foot.

The equipment of the present plant is of interest. Compressed air is furnished by 410 cu.ft. Imperial Type 10, duplex Ingersoll-Rand compressor driven by a 75-hp. motor. A 4-in. compressed air main is installed in the adit. Ventilation is provided by a 10-in. galvanized steel air pipe receiving its air from a small Root blower operated by a motor and with bypass for exhausting or blowing. A small Westinghouse-Baldwin, Edison storage battery locomotive is used for transportation. A charging panel with motor-generator is placed in a separate building convenient to the portal of the tunnel. The blacksmith shop, close to the portal, is equipped with an oil forge and drill sharpener, both of the Ingersoll-Rand type. Power is derived from a near-by hydro-electric transmission line. The adit was driven under contract.

Adit tunnel driven to explore Tertiary River channel

Tom Reed Hits Gold Orebody at 950 Level

A RICH orebody has been struck at the 950 level of the Tom Reed mine, in the Oatman district, Arizona. About 7 ft. of the gold-bearing rock assayed better than $40 to the ton. The body at the present intersection is wider and of better value than the shoot opened at higher levels. The strike was made in cutting out the station at the 950 level of the Aztec winze.

Drifting has been started in both directions from the new strike. Later the main shaft will be sunk to this, or a lower, level and the body entered from that point. As the shoot has been explored to a length of 240 ft. on the level above, with the possibility that it may extend to more than 700 ft., the possibility exists that the new body will prove of considerable extent. The strike will encourage mining at depth throughout the Oatman district.

The Tom Reed has already produced $15,000,000 in gold. Oscar Howard is the general manager, in charge of the new operations.

Strike Reported on 250-ft. Level of Big Jim Mine

A new orebody is reported to have been encountered in the Big Jim mine, in the Patagonia district of Arizona. It was found in the north drift on the 250 level. A crosscut has been driven 31 ft. through the vein without reaching the footwall and a drift has been extended for 25 ft. along the hanging wall. The ore shows gold, silver, lead, and zinc. A crosscut has been started toward the new vein, 100 ft. below the 250 level. The ore is being treated in the company's 75-ton selective flotation mill.

Toronto Letter

By Our Special Correspondent for Northern Ontario

Noranda Employee Arrested for Conspiring to Obtain Data on Flow Sheet

TORONTO, June 29, 1929.—The first case of its kind in the history of eastern Canada has arisen out of the arrest of J. H. Alexander, a former employee of Noranda Mines, at Rouyn, in Quebec. He is charged with conspiring with employees of the Horne Copper Corporation, the operating company for Noranda, to obtain information contrary to the provisions of the Criminal Code. When arrested, Alexander had a number of documents in his possession, including photographs of the smelter flow sheet, assay records, and other important information. Three other arrests were made among employees of the Horne, all of whom, however, were later released. Alexander is out on bail, which has been set at $10,000.

EVER since the development of high-grade ore at the Frood mine, there has been much interest, but very little information, regarding the precious-metal contents. Robert C. Stanley, president of International Nickel, however, in an interview, has stated that the results from smelting ores taken from the crosscuts on the 16th, 20th, 24th, and 28th levels of that mine indicate a net return of approximately $50 per ton in precious metals. The number of tons of ore required to make a ton of matte varies between nine and fifteen. Of the total value of $50, approximately 75 per cent is accounted for by metals of the platinum group, the balance being gold and silver.

Northern Ontario Power, supplying power to the gold and silver mines of northern Ontario, will start the development of the Upper Notch power site, on the Montreal River. This falls is 5 miles below Fountain Falls and is capable of developing a total of 13,000 hp. It will be connected with the existing transmission lines and will be available for distribution in the mining camps of northern Ontario and northwestern Quebec served by the associated power companies. The designing, engineering, and construction of the development will be done by the staff of the Power Corporation of Canada. As the South Lorrain branch of the Nipissing Central Railroad passes within a short distance of the site of the plant, construction can be carried on quickly and economically. Development is expected to take two years to complete, with a minimum of 200 men employed.

Ventures, Ltd., has optioned the McCrea-Simmons property in the Crow River district of Ontario. A discovery was made on this property last fall, and encouraging assays were obtained from preliminary sampling.

An announcement of plans in connection with the zinc refinery which is to be built jointly by Consolidated Smelters and Ventures, Ltd., is expected soon. The recent transaction by which the Flin Flon smelter would treat the Sherritt-Gordon copper concentrates and leave the zinc concentrates of both properties to be taken care of by Ventures, Ltd., is believed to pave the way for the final details of the zinc plant.

H. E. Harcourt, managing director of the Jackson-Manion Mines, was recently found guilty, by Justice O'Connell of the County Judges Criminal Court, of issuing reports and statements in connection with the mine which were false in material details and of doing this with intent to defraud shareholders or to induce persons other than shareholders to become interested in the property. Mr. Harcourt was sentenced to fifteen months in the Guelph Reformatory, but has entered an appeal and is now out on bail of $75,000.

Start National Drive Against Fraudulent Securities

A CONCERTED movement to run to cover perpetrators of securities frauds, who take from the pockets of the American people from $500,000,000 to $1,000,000,000 annually, is in process of being launched by interested organizations. Steps looking to a coast-to-coast attack upon this kind of swindling were taken at a recent meeting held at the Chamber of Commerce of the United States at which the National Association of Securities Commissioners, the Investment Bankers Association of America, the National Chamber, the American Bar Association, the National Better Business Bureau, the American Bankers Association, the Associated Stock Exchanges, and other organizations were represented.

An organization committee is now at work laying plans for a conference to be held probably later in the year, at which the attack will be formally launched. More effective laws and practices aimed at the regulation of the issuance of securities will be demanded.

Rhodesian Drilling Results

N'CHANGA COPPER MINES reports ore cut at a depth of 815 ft. by drill hole B.19, which has been put down on the Dambo lode, about 900 ft. northeast of drill hole B.13 and about 1,500 ft. east of drill hole B.17. The hole continued in ore for 100 ft., averaging 5.1 per cent copper. Assays for 75 ft. of this total—from a depth of 825 ft. to 900 ft.—averaged 6.2 per cent copper.

Johannesburg Letter

BY OWEN LETCHER
Special Correspondent

Emeralds Added to List of Minerals Produced in Transvaal Province

JOHANNESBURG, May 26, 1929.—A new mineral, beryl, with its precious associate, the emeraid, has been added to the list of minerals produced in the Transvaal. A year or two ago, attention was directed to certain biotitic schist deposits containing crystals of a greenish hue, existing in northern Transvaal. After examination by Johannesburg geologists, they were stated to be beryls and the possibility of finding the true emerald variety of the mineral was said to be good. This mineralogical determination proved correct, and the Somerset mine is now producing from 300 to 500 lb. of crystals weekly, from a total gross tonnage mined of about 300. About 5 or 10 lb. of crystals of true emerald color is picked out from this production and is shipped to London to be examined by experts, who decide how to treat each crystal.

ON present production of 50 tons daily, profits, without allowing for any exceptionally fine gem crystals, are approximately £800 per month. Expenses are about £300. In February the board of directors of Beryl Mining, the pioneer company, decided to issue 10,000 reserve shares of 2s. par. With the extra capital secured, a complete mining and treatment plant will be constructed to cost about £5,500, according to estimates. When this plant is running, and this is expected about the end of July, the tonnage mined will be increased to 200 tons daily. At present, the main pit has reached a depth of 40 ft. from from the surface. The diameter to the excavation is about 100 ft. After dynamiting, the ore is trammed to the sorting shed through an adit in the south side of the mine. The sorters pick the crystals out of the loose material in the sorting shed. When the new plant is installed this work will of course be done by machinery, thus eliminating the "high-grading" through which a considerable amount of the production is lost.

The deposit itself is about 200 ft. wide at the western end and about 20 ft. wide at the eastern end. The length is about 1,000 ft. As a result of the success of Beryl Mining, about 60,000 precious stone claims have been pegged in the district, the holders including some important mining companies.

Another discovery which has attracted attention has been made in the Pietersburg district of the Transvaal. where a scheelite deposit, said to be of commercial importance, has been found. Prospect holes put down at intervals of 6 ft. have followed the deposit for a length of about 260 ft.

MARKET AND FINANCIAL NEWS

German Metal Trade Hesitant

Electrolytic Zinc in Better Demand; Russian Efforts to Establish an Aluminum Industry Discussed

By Dr. James Rubinfeld
Special Berlin Correspondent

AS MIGHT HAVE BEEN EXPECTED, German metal imports during the present somewhat critical year have decreased in the aggregate in comparison with 1928. The comparative imports were, according to official statistics now at hand, in metric tons during January-April, as follows:

	1929	1928
Aluminum	3,556.0	5,323.4
Lead	56,166.0	57,149.0
Zinc	41,852.8	50,217.0
Tin	4,812.0	4,779.0
Nickel	1,446.0	1,482.6
Copper	67,725.4	82,513.0
Antimony	1,040.7	844.0
Chromium, Cadmium, Molybdenum and others	161.3	566.5

Of primary significance is the large decrease of copper imports, as a consequence of price enhancements; and of minor metals, because of the plight of the stainless steel industry in Germany. In the bearing-metal industry a formidable new competitor has arisen in the form of the Swedish SKF-Trust, of Gotenburg, which also has managed to bring three-fourths of the entire German ball-bearing industry under its control and which will be provided with raw material mainly from Sweden. Another feature is the decrease in nickel imports, though Germany had only begun to show promise of becoming a big nickel consumer. The official statistics, for the first time, indicate the proportion of electrolytic zinc coming into Germany, whereas hitherto the locally termed "fine" zinc was erroneously considered as identical with other slab zinc. It is a coincidence, by the way, that the quantity of 8,206 tons of "fine" zinc (chiefly from the United States and Canada) is a fifth of the total zinc imports, corresponding directly with the world proportion of electrolytic to zinc metal otherwise produced. The trend is decidedly to the application of more of the electrolytically made metal. The Giesche plans reckon with this trend.

According to compilations of the Frankfurt Metallgesellschaft, the German zinc production in January-May, 1929, amounted to 43,083 tons, against 39,815 tons in the first five months of 1928. As a sign of the further extension of electrolytic zinc-production facilities in Europe, it may be noted that the half-Spanish concern of Penarroya is harnessing water-power in the Pyrenees (at St. Cricq and St. Lary), contemplating the erection of an electrolytic zinc plant at Bayonne. Meanwhile, Penarroya proceeds to make use of the Anaconda electrolytic-zinc process patents in the plants of its Italian subsidiary. Rumors are heard in Germany that the Brussels Zinc Cartel, which recently was provisionally prolonged for some months, is negotiating further with the Americans, presumably regarding the Canadian and Mexican production controlled by United States concerns. In the European zinc world a sort of concentration of battle forces is going on. Belgium's output is declining further from former record proportions and Belgian zinc rollers who hitherto had competed for markets in western Germany are said to seek terms with the German rolling mills in order to avoid further disastrous price competition. Among zinc-producing countries the United States and Belgium report a decrease in output from the preceding year, whereas Germany and Polish Upper Silesia, for example, have on the whole increased their production.

Recently an interesting compilation of the Central Union of German Metal Smelters and Rollers in Berlin, which comprises 67 works in Germany, has been published. From it may be gathered that the entire smelter and rolling mill production for 1927 (530,000 tons of aluminum, lead, zinc, tin, nickel, copper, and brass fabricated products) had a value of 850 to 880 millions of reichsmarks, and the value of smelter production totaled 507,816,000 reichsmarks. A total of 89 smelters and refineries employed 17,761 workers, the payroll amounting to 41,765,000 reichsmarks; rolling-mill employees totaled 28,206. Assuming the daily workings of the years 1925-26 as an index of 100, the efficiency of the pre-war year 1913 was only 92.4, whereas in 1928 it amounted to 136.5 One may see from these data that the rationalization movement in the metal-manufacturing industry of Germany has borne fruit, and without the broad United States capital basis at that.

The French Electrométallurgie de Dives has acquired some copper prospects in Bulgaria which are said to be rich, in seeking to provide sources of its own raw stuffs. With the same view in mind, another acquisition of a Scandinavian copper mine which is believed to yield around 7,000 tons of metal yearly has been made by the intermediary of the Kreuger and Tell concern. Dives should exploit the latter mine through its subsidiary company, the Compagnie Générale de Mines et de Métallurgie. Thus the self-supply aims are increasing in Europe on account of the arbitrary copper price policies at Brussels. Of course, some European copper producers are, on the other hand, benefiting from them, as may be seen from the case of the Norwegian Orkla mine (concern of Wallenberg), the profit margin of which amounted to 3.37 millions of kroners, against 1.87 millions in the preceding year. And similar is the situation with regard to Mansfield, Rio Tinto, and others in Europe, which should be able to distribute higher dividends for the present year.

Russia continues to search for help in the planning of a domestic aluminum industry. I understand that some months ago the Soviet authorities, after the "echec" of the negotiations with the Americans, and especially with Dr. Anderson, sent specimens of the Tischwinsk bauxite into the Lautawerke. Perhaps the idea continues to prevail that the Haglund thermic process, of which the latter holds the license rights —and which is utilized by the Montecatini in its newly erected Mori plant and others in Italy—may serve to develop a Russian aluminum industry. Russia is concerned with the disposal of the bauxite fields of Tischwinsk (Severni Novgorod, near Leningrad) and of Elizabeth-Kol (Caucasus), of laterite fields near Batum and alunite deposits in the State of Azerbaijan. Thus far only the Tischwinsk fields have been given serious consideration, though the aluminum content of these deposits varies over a wide range. A large portion of this bauxite has as much as 30 per cent silica, albeit it descends also to only a few per cent in other portions. Notwithstanding, the Russians are insisting upon having an industry of their own so that they may become independent of American copper, especially in times of war, which always forms a sort of bugbear there. The Russian mining experts are contemplating a production of 250,000 or even 300,000 metric tons of pure aluminum from the Tischwinsk district

London Financial News

By W. A. Doman
Special London Correspondent

London, June 18, 1929—Tin has come to the front again, displacing copper in market interest. Last week I mentioned the suggested formation of a British Tin Producers' Association. Registration particulars for the British American Tin Corporation, Ltd., are now available. Its initial capital is £1,000,000 in £1 shares. To gain some idea of its importance, it is necessary to mention the names of the subscribers (with one share each). They are: Sir Hugo Cunliffe-Owen, Bt.; Lord Brabourne; O. V. G. Hoare; Sir J. A. Mullens; Caracoles Tin Company of Bolivia, by J. J. Lennon, its authorized attorney; Carlos V. Aramayo, president of Compagnie Aramayo de Mines de Bolivie, Geneva; Hugh Micklem, banker; and John Howeson.

Sir Hugo Cunliffe-Owen is a director of the Midland Bank and chairman of the British American Tobacco Company; Lord Brabourne is a director of Consolidated Gold Fields of South Africa and of Ropp Tin (Niagara); Sir J. A. Mullens is a stockbroker; Hugh Micklem is a financier, and director of two Chester Beatty companies; John Howeson is chairman of Anglo-Oriental Mining Corporation and of London Malayan Tin Trust; and Oliver Hoare is a director of the Consolidated Gold Fields of South Africa. If, as seems probable, the above subscribers represent the companies with which they are connected, it is obvious that the British American Tin Corporation is one of the most powerful mining trusts yet formed in this country. Presumably the corporation has been constituted to stabilize or rationalize the tin industry. Comments, both favorable and unfavorable, have been made. The directors may be able to take superfluous stocks of metal off the market and hold for a substantially higher price, say £225 to £250 a ton. Some who favor the scheme say this can be easily done and point out the Bandoeng agreement of two or three years ago. Other people remark upon the absence of big Malayan names, such as Osborne and Chappell and C. V. Thomas, to say nothing of Chinese owners. This last group would, of course, benefit by any rise in prices, though they can earn good profits at the current level. One significant fact is that the Guggenheims are interested in the undertaking.

The Perak River Hydro-Electric Power Company is now supplying current to new dredges belonging to Penawat (Malay) Tin Dredging, and Kampar Malayan Tin Dredging. As the dredges were put into operation on May 18 and 19 respectively, and the news has just been given out, it is assumed that working is satisfactory.

The Burma Corporation has declared a final dividend of 7 annas per share and a bonus of 2 annas, free of all taxes, making a total of 16 annas for the twelve months ending June 30. In the previous year the total dividend was 12 annas.

At the Poderosa meeting, Lional W. Harris, the chairman, said that the Chilean government had passed a law to establish a national smelter to found a home industry, and that an export tax of 30 per cent on all copper ores is proposed. The scheme will not go into effect immediately.

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alone. The problem is being thoroughly studied by the so-called Aluminiumstroy, a section of the Supreme Economic Council of the Soviet Union. In German circles the cost of power—that is to say, the kilowatt-hour price per unit of aluminum produced—is considered an adverse factor, for even by utilizing power from the big Dnieperstroy water works, the price per kilowatt-hour would be double that of American electricity. Also, the amount of electricity needed to produce a ton of aluminum from the Russian ore is greater. Meanwhile, Russia needs at least 10,000 tons of aluminum yearly, which is partly supplied in England and Germany or elsewhere on narrow credit terms. In Russia, as in the rest of Europe, the propaganda for substituting aluminum for copper in the power transmission, cable, and wire fields is being continued. Some increase of aluminum demand from this condition may surely be foreshadowed there.

With regard to the aims for forming a sort of world cartel of tin, the general views here are very sceptical thus far. Those interested expect, however, that the endeavors of some London groups will be reiterated in a stronger way, and perhaps the metal traders who have lost their former influence in this speculative field will be prone to participate in driving prices up. The general trend in London goes to combinations of industrial groups with trading firms (see recently the grouping of Henry Gardner & Company-International Nickel Company-American Metal Company). German opinion is that a well-rounded world cartel remains a long way off, because of the conflicting interests of those concerned. It may be mentioned here, by the way, that the Th. Goldschmidt Aktien Gesellschaft, of Essen, known as a producer of secondary tin from tin plate, stresses the fact that this business has become very difficult because of the thin covering of tin on the present output of tin plate. The American example of sparing tin in tinplate making has made detinning a very unremunerative matter for many small firms, although with their special processes Goldschmidt's are able to make some profits even yet.

The Italian quicksilver concern of Monte Amiata has once more distributed a dividend of 45 per cent for the preceding year. Several Swedish iron founders and steel makers have combined to acquire a chrome ore deposit in Asia Minor.

Closer Relations Urged in Zinc Trade by V. M.

In THE annual report of Vieille Montagne, the leading Belgian zinc producer, particular emphasis is given to the problem of cartelization in the zinc industry and to the necessity for closer relations among the various producing interests. The company feels that it is essential to emphasize the necessity of considering the entire question in a broad spirit, so as to reconcile private interests, in a reasonable way, with the general interests of the industry and trade. Particularly, support should be given to organizations which have the object of popularizing and multiplying the uses of zinc.

In 1928, the company produced 110,000 tons of zinc at its various plants in Europe. Present plans call for an output of about the same size during the present year, although the potential producing capacity is 125,000 tons. Its production is about 7.8 per cent of the world production, which showed an increase in 1928 of about 6.4 per cent over the world production in 1927.

Anaconda Makes Offer for Andes and Greene Can. Stock

As A FURTHER STEP in the consolidation of its holdings, Anaconda Copper has announced that it has made an offer for the outstanding shares of Greene Cananea Copper and Andes Copper. Anaconda already owns more than 51 per cent of Andes and a substantial amount of Greene Cananea. It is believed to have increased its holdings of Greene Cananea recently and, according to Wall Street reports, now has working control, although possibly not a majority stock interest.

The offer announced recently is to exchange 1½ shares of Anaconda for 1 share of Greene Cananea and 45 shares of Anaconda for every 100 shares of Andes. Outstanding shares of Greene Cananea total 500,000. The outstanding stock of Andes consists of 3,582,379 shares. Anaconda has outstanding about 7,600,000 shares of an authorized issue of 12,000,000 shares, leaving an ample margin to take care of exchange proposed to Andes and Greene Cananea holders. Anaconda will apply to the Stock Exchange to list the additional stock.

John D. Ryan, chairman of Anaconda, stated that the operations of Andes during the first half of this year had been at the rate of about 200,000,000 lb. of copper a year, although production was recently curtailed. It is intended to increase the output to a basis of 230,000,000 lb. a year. Greene Cananea produced in the early part of this year at the rate of 75,000,000 lb., but its output also has been restricted recently.

The Market Report

Metal Markets Lethargic

New York, July 3, 1929—Volume of copper sales continued in small amount during the last week. Some factors interpret this inactivity as "the lull that precedes a storm (of buying)." In other directions a somewhat less optimistic viewpoint is taken. Undoubtedly the approach of the Fourth of July holiday interval has been a factor in keeping buyers out of the market. Custom smelters continue to take the bulk of the business, and prices are unchanged at 18c., delivered Connecticut Valley, basis. Copper Exporters, Inc., c.i.f. price likewise is unchanged at 18.30c. Demand from abroad continues at about the same rate prevailing during June—slightly less than 1,000 long tons per day.

Daily Prices of Metals

June July	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
27	17.775	44.50	7.00	6.775@6.80	6.80
28	17.775	44.50	7.00	6.80	6.80
29	17 775	44.625	7.00	6.80	6.80
1	17.775	44.625	7.00	6.80	6.70@6.80
2	17 775	44.750	7.00	6.80	6.70
3	17 775	45.125	7.00	6.80	6.70
	17 775	44.688	7.00	6.798	6.758

Average prices for calendar week ending June 29, 1929, are: Copper, 17.775; Straits tin, 44.500; New York lead, 7.000; St. Louis lead, 6.798; zinc, 6.763; and silver, 52.333.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted.

Quotations for copper are for the ordinary forms of wire bars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up, depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

June July	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic bid						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
27	73 1/2	73 1/8	83 1/2	201	204 1/2	23 5/8	23 1/2	26 3/16	25 3/16
28	73	72 7/8	83 3/4	201 1/2	204 3/4	23 3/8	23 1/4	25 11/16	25 1/2
1	73 1/2	73 1/4	84	202	205 1/2	23 3/8	23 5/16	25 5/16	25 3/8
2	73 3/8	73	84	201 3/4	205	23 3/8	23 5/16	25 7/16	25 7/16
3	72 7/8	73	84	204	207	23 1/8	23 1/16	25 7/16	25 7/16

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

June	Sterling Exchange "Checks"	Silver		Gold London	July	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
27	4.84 1/4	52 3/8	24 1/8	84s11 1/2d	1	4.84 1/4	51 7/8	24 1/16	84s11 1/2d
28	4.84 5/16	52 1/2	24 1/4	84s11 1/2d	2	4.84 1/4	51 7/8	24	84s11 3/8d
29	4.84 5/16	52 1/4	24 1/8	.....	3	4.84 1/4	51 7/8	23 15/16	84s11 1/2d

Average: Silver, 52.125c.; Sterling Exchange, 484.271c.

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, basis 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-half cent premium.

Average Metal Prices for June 1929

COPPER:	
New York Electrolytic	17.775
London Standard Spot	74.338
London Electrolytic Spot	84.013
LEAD:	
New York	7.000
St. Louis	6.790
London Spot	23.694
London Forward	23.603
SILVER:	
New York	52.415
London	24.258
Sterling Exchange	484.330
ZINC:	
St. Louis	6.686
London Spot	26.216
London Forward	25.984
TIN:	
Straits	44.240
London	200.206
QUICKSILVER	120.500
ANTIMONY	8.845
PLATINUM:	
Refined	68.000
Crude	58.000
ALUMINUM 99 Per Cent Plus	24.300

Lead Market Unsettled

Although lead prices held firm throughout the week, the general tone of the market at the close was unsettled, owing particularly to the recession of London quotations, which declined 5s. today. Total sales were more than 25 per cent less than those for the preceding week. Should London prices decline further, a downward readjustment of the domestic price is probable.

The closing sentence of last week's lead report indicated that parity between London and New York prices on June 26 favored the sale and retention in this market of foreign bullion, refined here, by a margin of about $1 per ton. This statement was misleading, though today's quotations do favor such action.

Zinc Quiet but Firm

Much of the week's zinc business was crowded into the last two or three business days in June, and, oddly enough, all of it represented sales by the larger producers at 6.80c. Since Monday of this week, however, sales have been somewhat better distributed, but in smaller volume, at prices ranging from 6.65c. to 6.80c. The one lot that changed hands at 6.65c. represented a special transaction by a dealer with spot zinc on his hands that he was willing to turn over at a discount, but quotations below 6.70c. East St. Louis would be difficult to locate this afternoon.

Tin Advances

The week closed with a good speculative demand in London for tin, the price

advancing 45s. for spot metal abroad and to 45⅛c. in New York today. Among other influences to which the current strong character of the market is attributed is the calling of another meeting of the world's leading tin producers, which, according to reports, is to be held in London on July 11. Important interests which have not been represented at similar previous conferences will participate in the forthcoming proceedings, it is said.

Silver Market Weak

Weakness in China exchanges has again been the cause of a sagging silver market, with little interest shown by either China or India.

Mexican Dollars (old Mexican pesos): June 27th, 39¾c.; 28th, 39⅞c.; 29th, 39⅝c.; July 1st, 2d, and 3d, 39⅜c.

Foreign Exchange

Closing cable quotations on the principle foreign exchanges on Tuesday, July 2, were: Francs, 3.91 7/32c.; lire, 5.23 7/16c.; and marks, 23.82½c. Canadian dollars, 3/32 per cent discount.

Tri State Concentrate Prices Unchanged

Joplin, Mo., June 29, 1929

Blende	Per Ton
High	$46.55
Premium blende, basis 60 per cent zinc	$44.00@ 45.00
Prime Western, basis 60 per cent zinc	43.00@ 44.00
Table concentrates, 60 per cent zinc	41.00@ 43.00
Flotation concentrates, 60 per cent zinc	39.00@ 41.00
Average settling price, all zinc concentrates	44.09
Galena	
High	$93.60
Basis 80 per cent lead	90.00
Average settling price, all lead concentrates	91.21

Shipments for the week: Blende, 11,933 tons; lead, 1,896 tons. Value, all concentrates the week, $698,940.

Shipments for six months: Blende, 323,272 tons; lead 56,312 tons. Value, all concentrates for six months, $18,871,540.

The car shortage has been sufficient to hold shipments below purchases, but not enough to create anxiety. Despite earlier opinion to the contrary, the railroads apparently have rolling stock to supply the demand of 1,000 cars daily for grain shippers, and still take care of concentrate shipments in this district. Prices remain unchanged today for both zinc and lead concentrates.

Platteville, Wis., June 29, 1929

Zinc Blende	Per Ton
Blende, basis 60 per cent zinc	$46.75
Lead Ore	
Lead, basis 80 per cent	$90.00

Shipments for the week: Blende, 738 tons; lead, 80 tons. Shipments for the year: Blende, 17,451; lead, 940 tons. Shipments for the week to separating plants, 1,714 tons blende.

Steel Production Expected to Taper Off in Last Half 1929

Pittsburgh, July 2, 1929

Steel-ingot production in the first half of 1929 was fully 29,000,000 long tons, 15 per cent above that in the second half of 1928 and 16 per cent above that in the first half; and the twelve months through June ran about 16 per cent above production in any preceding period of twelve months. Since the middle of last year there has been a remarkable bulge above the general trend line, which previously had indicated average annual gains of about 3 per cent.

Steel-ingot production in May made a new all-time record both for a month's total and for daily rate. Absence of seasonal decrease during the second quarter of the year is unprecedented.

While there has been virtually no seasonal decrease to date, there is, if anything, the more reason to expect the second half to follow the usual course and show a decrease from the first half, perhaps in the neighborhood of 10 per cent. Last year was exceptional in not showing a decrease.

PIG IRON.—For June, when there is usually contracting for third quarter, pig iron has been decidedly dull in all districts. Valley prices remain quotable at $19, furnace, for Bessemer and malleable and $18.50 for basic and foundry.

CONNELLSVILLE COKE.—The market has been quite dull, but spot prices have easily held, at $2.75@$2.85 for furnace and $4@$4.25 for foundry.

Other Metals

Quotations cover large wholesale lots, f.o.b. New York, unless otherwise specified. London prices are according to latest mail advices.

ALUMINUM—Per lb., 99 per cent plus grades, price of leading interest, 24.30c. Outside market, 99 per cent plus, 24.30c.; 98-99 per cent, 23.90c. London, 98 per cent, quoted at £95 per long ton, less 2 per cent for domestic consumption.

ANTIMONY—Per lb., duty paid: Chinese brands, for all positions, 8⅝c. Cookson's "C" grade, spot, 14c. Chinese needle, lump, 8c. Standard powdered needle, 200 mesh, 10c. Nominal.

BISMUTH—Per lb., in ton lots, $1.70. Smaller lots $1.85 and up. London 7s. 6d.

CADMIUM—Per lb., 80@95c. London, 4s. 1d.@4s. 2d. for prompt.

CHROMIUM — Per lb., 97 per cent grade, $1.50.

COBALT — Per lb., f.o.b. Canadian works: Shot or rondelles, 96@98 per cent, $2.50. Contract sales booked at discounts, depending on quantity. Black oxide, 70 per cent, $2.10. London, nominal, 10s. for metal in small lots, 8s. for black oxide; 8s. 10d. for gray.

[1]GERMANIUM OXIDE—Per gram in 300- to 500-gram lots, $3.50.

IRIDIUM—Per oz., $230@$240 for 98 @99 per cent sponge and powder. London, £50@£52.

[1]LITHIUM—Per oz., 98@99 per cent grade in 1- to 5-lb. lots, $5.

MAGNESIUM—Per lb., in ton lots, single orders for spot metal: 8-lb. ingots (3x3x15 or 16 in.), 85c.@$1.05, depending on quantity; 2½- or 3-lb. sticks (1⅛ in.), $0.90@$1.10, depending on quantity; 10-oz. sticks (1x12 in.), 80@90c. Discounts up to 20 per cent on larger orders or contracts. London 3s. 3d.@3s. 9d. for 99 per cent ingots or sticks.

[1]MOLYBDENUM—Per lb. in 1- to 3-lb. lots, 99 per cent, $18. (Usually sold as calcium molybdate or ferromolybdenum, which see).

NICKEL—Per lb., ingot 35c.; shot 36c.; electrolytic, 35c. (99.90 per cent), for single lots of spot metal. London, per long ton, £170@£175 according to quantity. *Metal Bulletin*, London, reports demand being maintained on a large scale, and despite the increased productive capacity which has been developed during the last year or two, supplies are none too plentiful.

OSMIUM—Per oz., $58@$65; London, £12@£14.

PALLADIUM — Per oz., $38@$40. London, £7 5s.@£8 5s.

PLATINUM—Official price quoted by the leading interest on small miscellaneous orders for refined metal, per oz., $68. Transactions between dealers and refiners in the outside market are commonly reported at several dollars less.

London, per oz., £13 10s.@£13 15s. for refined; crude and scrap, nominal at £11 10s.@£12.

QUICKSILVER—Per 76-lb. flask, $120 @$121. Small lots command usual premiums. Fair demand reported by some dealers; market spotty. San Francisco wires $122.67 for retail and small wholesale lots. London quiet, with offers of spot at £22 2½s.@£22 5s.

RADIUM—Per mg. radium content, $70.

RHODIUM—Per oz., $45@$55. Nominal. London, £9 10s.@£11.

RUTHENIUM — Per oz., $42@$50., Nominal. London £9@£10 10s.

[1]SELENIUM — Per lb. in ton lots: Black, powdered, amorphous, 99.5 per cent pure, $2.25. London, 7s. 8d.@ 7s. 9d.

TANTALUM — Per gram: Bar and heavy sheet, chemically pure, 16c.; tantalum powder, 11c. Recent decline in price occasioned by production economies, resulting from higher output. Good demand.

TELLURIUM—Per oz., 15@18c.

THALLIUM METAL—$12.50@$15 per pound.

TITANIUM—Per lb., 80@90 per cent grade, $5.

TUNGSTEN POWDER—Containing 97 to 98 per cent tungsten, per lb., $1.35@ $1.50, depending on quantity. Nominal.

VANADIUM—Per gram, 92@95 per cent grade, $1.25.

[1]ZIRCONIUM METAL—Per oz., 98 per cent grade, $1.56 in 5- to 10-lb. lots.

[1]Price furnished by Foote Mineral Co., Philadelphia.

Metallic Ores

ANTIMONY ORE—Bolivian ore, 60 per cent metallic antimony, $1.35 per short ton unit, c.i.f. New York.

CHROME ORE—Per long ton, f.o.b. Eastern shipping points, Indian and Rhodesian ores, $22 for 47 per cent Cr_2O_3 ore to $24.50 for 50@51 per cent ore. New Caledonian ore, high-grade, $25.

IRON ORE—Per long ton, lower Lake ports. Lake Superior ores:

Mesabi, non-bessemer, 51½ per cent iron, $4.50. Old Range, non-bessemer, $4.65.

Mesabi, bessemer, 51½ per cent iron, $4.65. Old Range, bessemer, 51½ per cent, $4.80.

Eastern ores, cents per unit, delivered at furnaces: Foundry and basic, 56 to 63 per cent, 8c.

Foreign ores, f.o.b. cars Atlantic ports, cents per unit:

North African, low-phosphorus, 12@12½c.

Spanish and North African basic, 50@60 per cent, 11½@12c.

Swedish foundry or basic, 66@68 per cent, 9@10c.

Newfoundland foundry, 55 per cent, 8½@9c. Nominal.

MANGANESE ORE—Per long-ton unit of Mn, c.i.f. North Atlantic ports. Exclusive of duty. Brazilian and Indian ores, minimum 47 per cent Mn, 30@32c. Caucasian, 53@55 per cent, 36c.

Per ton in carload lots:

[1]Chemical grades, powdered, coarse or fine, 82@87 per cent MnO_2. Brazilian and Cuban, $70@$80. Caucasian, minimum 85 per cent, $70. Montana, 70 to 75 per cent, $70@$80. Domestic, 70 to 72 per cent, $40@$50.

TANTALUM ORE—Per unit of Ta_2O_5, basis 60 per cent ore, $13.

TITANIUM ORE—Ilmenite, per gross ton, 50 per cent TiO_2, f.o.b. Atlantic seaboard, $9.50@$11, according to grade and impurities. Low-grade domestic, 32 to 35 per cent, about $7@$8 per gross ton. Rutile, per lb., guaranteed minimum 94 per cent concentrate, 10c. in carload lots.

TUNGSTEN ORE—Per short-ton unit of WO_3, N. Y.: Wolframite, $15.50@$16 for future delivery. No spot available and Chinese situation is such that no contracts are absolutely reliable. Bolivian scheelite is about the only material available for early delivery, quoted at $15.50. Western scheelite, $18.50 for October and November delivery.

VANADIUM ORE—Per lb. V_2O_5 contained, 28c.

ZIRCON ORE—Per net ton containing 55 per cent ZrO_2, f.o.b. Atlantic seaboard, $40@$45 in 30-ton lots.

Non-Metallic Minerals

Prices received for non-metallic minerals vary widely and depend upon the physical and chemical characteristics of the commodity. Hence the following quotations can serve only as a general guide to the prices obtained by producers and dealers in different parts of the United States for their own product. In the last analysis the value of a particular non-metallic mineral can be ascertained only by direct negotiation between buyer and seller.

[1]Price given by Foote Mineral Co., Philadelphia.

[1]AMBLYGONITE—Per ton, f.o.b. mines: 8@9 per cent lithium oxide, $50@$60.

ASBESTOS — Per ton: f.o.b. Quebec mines, tax and bags included, prices quoted by leading interest for delivery on 1929 contract:

Crude No. 1, $550@$750; crude No. 2, $450@$575; spinning fibers, $225@$275; magnesia and compressed sheet fibers, $175@$225; shingle stock, $55@$115, various grades; paper stock, $45@$50; cement stock, $25; short fibers, $10@$20; floats, $12@$15. Europe reports a general shortage of Canadian spinning fiber and No. 2 crude.

Per ton c.i.f. New York: Rhodesian crude No. 1, $450; No. 2, $350.

BARYTES—Per ton: f.o.b. mines, bags extra:

Georgia: Barytes ore, crude (per long ton), $6.50. Washed and water floated to 97 per cent through 300 mesh, $19. Demand easing off.

Missouri: Water ground and floated, bleached, $23; $25 in less than car lots, f.o.b. works. Crude ore, 93 per cent $BaSO_4$, not to exceed 1 per cent iron, $7.25 f.o.b. mines. Market good.

BAUXITE—Per long ton: Domestic ore, chemical, crushed and dried, 55 to 58 per cent Al_2O_3, 1.5 to 2.5 per cent Fe_2O_3, $7.50@$8.25 f.o.b. *Alabama* and *Arkansas* mines. Other grades, 56 to 59 per cent Al_2O_3, 5 to 8 per cent SiO_2, $6.75@$8.25 f.o.b. *Arkansas* mines. Pulverized and dried, $12@$14 f.o.b. *Arkansas* mines; calcined, 78 to 84 per cent Al_2O_3, $18@$20 f.o.b. *Arkansas* mines.

Per metric ton, foreign, c.i.f. Atlantic port: Dalmatian, 50 to 55 per cent Al_2O_3, 1 to 3 per cent SiO_2, $4.50@$6.50; Istrian, 54 to 57 per cent Al_2O_3, 3 to 5 per cent SiO_2, $5.50@$7; French, 56 to 59 per cent Al_2O_3, 2 to 5 per cent SiO_2, $6@$8.

BORAX—Per lb.: Carload lots, in bags, crystals, 2¾c.; granulated or powdered, 2½c.; f.o.b. consumers' shipping point.

[1]CELESTITE—Per ton in carload lots: 90 per cent $SrSO_4$, finely powdered, $27.

CHALK—Per ton: Crude in bulk, c.i.f. *New York*, $4.75@$5.

CHINA CLAY (KAOLIN)—Per ton: F.o.b. *Virginia* mines, crude lump, No. 1, $7; crude No. 2, $5.50; washed, $8; powdered and air-floated, $8@$15; ground. $7@$15.

Florida, pressed pottery, bulk, $13; ground, No. 1, $20; No. 2, $15. Sprayed mineral flour in 100-lb. bags (bags extra), No. 1, $20; No. 2, $17. Market fair.

Best grade, domestic, $16@$18, f.o.b. *Delaware* plants in carload lots.

Imported English, f.o.b. American ports: Lump, $13@$21; powdered, $40@$45.

DIATOMITE—Per short ton, f.o.b. producing plant:

Kiln-fired brick, $65; kiln-fired aggregate, ¼ in., $45; insulating powder, $25; natural aggregate, ¼ in., $18@$20; air-floated powder, $45; 80 to 85 per cent silica, 98 per cent through 200 mesh, $20 in carload lots.

EMERY—F.o.b. *Pennsylvania* and *New York* in 350-lb. kegs, per lb.: Greek Naxos, 6½c.; Turkish, 6½c.; Khasia, 6½c.; domestic, 3½c.

FELDSPAR—F.o.b. mine or grinding plant:

North Carolina, per long ton, No. 1 pottery grade, crude, $6.50@$7.50; glass grades, $5@$6.

No. 1, pottery, 140 mesh, $16; 200 mesh, $18. No. 2, enamel, 20 mesh, $10.25; 90 mesh, $12.75; 140 mesh, $13; 200 mesh, $14.75. No. 3, 20 mesh, $9. Market fair.

New Hampshire, per ton: Pottery grade, $8. Best quality lump, $9.

New York, per ton: f.o.b. cars, No. 1 crude, $9. Soda-potash feldspar, 140 mesh, first grade, $18 per short ton; 200 mesh, first grade, $20 per short ton.

Maine, per ton: Best pottery grade, ground, $19. Market slow.

FLUORSPAR — Per ton: F.o.b. *Kentucky* and *Illinois* mines:

Gravel, not less than 85 per cent CaF_2, and not over 5 per cent SiO_2, $18. Foundry lump, 85-5, $20. Ground, 95 to 98 per cent CaF_2, and not over 2½ per cent SiO_2, $32.50 in bulk; $36.50 in bags or barrels. Acid lump, 98-1, $32.50 in car lots. Market dull.

New Mexico: 85-5 gravel, $16.50; 85-5 lump, $16.50; 94-3 lump, $21; 97-2, ground, $33.

Foreign spar, duty paid, $19.40, tidewater.

FULLER'S EARTH — Per ton, f.o.b. *Florida:* 16 to 30 mesh, $16.50; 30 to 60 mesh, $18; 16 to 60 mesh, $17; 60 to 90 mesh, $14; 100 mesh up, $7. Market very good.

Powdered, import duty paid, $24@$25 per ton.

GARNET—Per ton; domestic, f.o.b. mines, $85.

Spanish grades, $60, c.i.f. port of entry.

GILSONITE — Per ton, carload lots, f.o.b. mines *Colorado:*

Selected grade, $33; seconds (mine run), $25.50. Normal market.

GRAPHITE—Per lb., f.o.b. *New York:* Ceylon lump, 7½@8½c.; chip, 6½@7½c.; dust, 3@5½c.; Madagascar flake, 6½@8c. Market fair.

No. 1 flake, 9@18c. No. 2 flake, 5@16c. Foundry facings, 3c. and up. Graphite facings, 4@8c. Amorphous and crystalline, fine ground, 4@8c. Foreign market easier, stocks building up in this country.

Crude amorphous graphite, $15@$35 per ton, according to grade.

GREENSAND—Per ton, f.o.b. cars, *New Jersey:* Screened and bagged, best grade, in carload lots, $20.

GYPSUM—Per ton, f.o.b. mill, depending upon location: Crushed, $1.50@$5; ground, $4@$9; agricultural, $4@$8; calcined, $4@$13.

IRON OXIDE (See Ocher)—Per lb.: Standard Spanish red, 3@4½c.; domestic earth, 2@4½c.

KAOLIN—See China Clay.

[1]LEPIDOLITE—Per ton: $20@$30 for ordinary grades. Nominal.

LIMESTONE—Per ton: f.o.b. shipping points, depending on location, either lump or crushed, 25c.@$3.

Agricultural, 75c. up to $5 for crushed or pulverized. Prices depend upon source, purity, and fineness.

MAGNESITE — Per short ton, f.o.b. *California* mines: Grade "A" calcined, 80 per cent through 200 mesh, $43; Grade B, $40; dead burned, $29; crude, $11. *Washington:* Dead-burned magnesite, $22@$24 per net ton, Chewelah, Wash.

MICA—Per ton, f.o.b. plant:

New Hampshire: Mine run, $250; clean shop scrap, $25; roofing, $25. White dry ground, 20 mesh, $28; 40 mesh, $38; 60 mesh, white, $55; off-color, $34; 100 mesh, $70; 200 mesh, $80. Granite mica facings for cement block and stucco use, $8@$12, depending on size between ¼ in. and 60 mesh. Market somewhat firmer.

North Carolina: White, ground, 20 mesh, $35; 70 mesh, $100.

Madagascar, amber, per lb., f.o.b. *New York*, duty paid: No. A1, $2.50; No. 1, $2; No. 2, $1.65; No. 3, $1.15; No. 4, 60c.; No. 5, 45c.

[1]MONAZITE—Per ton: (Minimum 6 per cent ThO_2), $80.

OCHER — F.o.b. *Georgia* mines, per ton: $19@$20 in sacks; $21@$22 in barrels; washed and water floated, $18; second grade, 99 per cent through 225 mesh, $18. Market good.

PHOSPHATE—Per long ton, f.a.s. or f.o.b. mines:

Florida, pebble, f.a.s., for export: 76@77 per cent, $7.15; 75 per cent, $6.40; 74@75 per cent, $6.15; 70 per cent, $4.65; 68 per cent, $4.10. Prices firm.

Florida, pebble, domestic: 76@77 per cent, $6.50; 74@75 per cent, $5.50; 72 per cent, $4.50; 70 per cent, $4. Dull.

Tennessee, ground, 90 per cent through 200 mesh, 33 per cent P_2O_5, $11.20 per short ton. Brown lump for acid manufacture, per gross ton, $6 on 75 per cent basis; $5.25 on 72 per cent basis. Non-acidulated, fine ground, 65 per cent, $8 (per short ton).

POTASH—The ruling contract prices are as follows:

	Bags	Bulk
Muriate of potash, 80@85 per cent, basis 80 per cent..	$36.75	$35.15
Sulphate of potash, 90@95 per cent, basis 90 per cent	47.75	46.15
Sulphate of potash-magnesia, 48@53 per cent, basis 48 per cent	27.50	25.90
Manure salt, 30 per cent...	21.95	18.95
Manure salt, 20 per cent...	15.50	12.50
Kainit, 14@16 per cent ...	12.60	9.60
Kainit, 12.4 per cent.....	12.10	12.10

Two thousand pounds' net weight, c.i.f. Atlantic and Gulf ports. German weights, tares and analyses.

PUMICE STONE—Per lb.: In barrels, powdered, 2½@4c.; selected lump, 5@7c.

PYRITES—Per long ton unit of sulphur: C.i.f. United States ports; guaranteed 48 per cent sulphur: Spanish, 13c.: Tharsis, furnace size, 2½ in. diameter, 14c. Cinder from ore to remain property of buyers.

[1]QUARTZ ROCK CRYSTALS—Per lb. in ton lots: Colorless, clear but flawed, pieces ¼ to ½ lb. in weight, 20c. For optical purposes, four times above price; larger crystals still higher.

SILICA—Per ton: Water ground and floated, in bags, f.o.b. Illinois; 325 mesh, $16@$50 for 90 to 99½ per cent grades. Market fair. Glass sand, f.o.b. producing plant, 75c.@$5 per ton; molding sand, 65c.@$3.50; blast sand, $1.35@$3.50.

[1]SPODUMENE — Per ton: $20@$30, depending upon lithium content.

SULPHUR—Per long ton for domestic market, $18 f.o.b. Texas mines; $22 for export, Atlantic ports. Prices in reality are on a c.i.f. basis, but the average price reduced to an f.a.s. figure is about as given. Open prices $1 to $3 higher than above.

TALC—Per ton, carload lots, f.o.b. works, containers included:

Vermont: 99 per cent through 200 mesh, extra white, $9@$9.50; 97½ to 98½ per cent through 200 mesh, medium white, $8.50@$9; packed in 50-lb. paper bags; prices $1 per ton less in burlap sacks plus 15c. net for bags packed 12 to the ton.

New York: Double air-floated, short fiber, 200 mesh, $13.75; 325 mesh, $14.75.

Georgia: Powdered, gray, $7.50@$10; yellow, $9@$12; red, $11@$13; roofing, $7.50@$9.

New Jersey: Soapstone, ground, $10@$12.

TRIPOLI—Per short ton, burlap bags, paper liners, minimum carload 30 tons, f.o.b. *Missouri:* Once ground through 40 mesh, rose and cream colored, $16. Double ground through 110 mesh, rose and cream, $18. Air-floated through 200 mesh, rose and cream, $27.50; mill run, $16. Fairly good summer demand.

Metallic Compounds

ANTIMONY OXIDE—White, Chinese, 99 per cent Sb_2O_3, 14½c. per lb. Nominal.

ARSENIOUS OXIDE (White arsenic)—Per lb., 4c.; delivered near by. Market firm. London, per long ton, £16@£16¼ quoted for Cornish white: Mexican high grade, £17, c.i.f. Liverpool.

CALCIUM MOLYBDATE OR MOLYTE — Per lb. of contained Mo, 95c., delivered.

COPPER SULPHATE (Blue Vitriol)—Per lb. in car lots, 6c., for either large or small crystals.

SODIUM NITRATE—Per 100 lb.; crude natural, in bags ex vessel, Atlantic ports, $2.17½ for July deliveries.

SODIUM SULPHATE (Salt Cake)—Per ton, bags, f.o.b. works, $20; in barrels, $22.

ZINC OXIDE—Per lb. in bags, in car lots: Lead-free, 6½c.; 10, 20 or 35 per cent leaded grades, 6⅝c.; French red seal, in bags, 9⅜c.

Alloys

[1]FERROCERIUM—Per lb., $8 in 15 to 75 lb. lots.

FERROCHROME—Per lb. of contained chromium, 60@70 per cent chromium, 4 to 6 per cent carbon, 11c. on requirement contracts; spot shipments about ½c. per pound higher. Freight allowed on carload lots east of Mississippi River and north of Baltimore. Market active.

FERROMANGANESE — Per gross ton furnace: Domestic and foreign, 78@82 per cent, $105. Spiegeleisen, 19@21 per cent, $34 on carload business, f.o.b. furnace.

FERROMOLYBDENUM—Per lb. of Mo, f.o.b. shipping point, 50@60 per cent Mo, $1.20.

FERROPHOSPHORUS—Per ton, 18 per cent P, $91; electrolytic, 24 per cent, $122.50; f.o.b. *Alabama* and *Tennessee*.

FERROSILICON—Per gross ton, f.o.b. works, freight allowed on carload lots east of Mississippi River and north of Baltimore: 50 per cent, $83.50; 75 per cent, $130; 15@17 per cent, $45, f.o.b. Suspension Bridge, N. Y. Quotations for spot shipments $5@$10 per ton higher on 50 and 75 per cent grades.

FERROCARBONTITANIUM — Per ton: $160, f.o.b. producer's plant.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent W, $1.35@$1.45 f.o.b. works. Market firm.

FERROVANADIUM—Per lb. of V contained, f.o.b. works, freight allowed, $3.15@$3.50, depending on grade and quantity. Market active.

NICKEL SILVER—Per lb. for 18 per cent nickel Grade A sheets, 34½c.

YELLOW (MUNTZ) METAL—Dimension sheets, per lb., 25c.; rods per lb., 22¼.

Rolled Metals

COPPER—Sheets, hot-rolled, per lb., 27¾c.; wire, per lb., f.o.b. mill, 19⅞c.

LEAD SHEETS—Full rolled, 11c. per lb.; clipped, 11¼c.

MONEL METAL—Per lb., sheets, full finished, 42c.; rods, hot-rolled, 35c.

NICKEL—Per lb., sheets, full finished, 52c.; rods, hot-rolled, 45c.

ZINC SHEETS—Per lb., 10½c., f.o.b. works.

Refractories

CHROME BRICK—Per net ton, f.o.b. shipping point, $45.

FIRECLAY BRICK — Per M.: First quality, $43@$46, *Ohio, Kentucky, Central Pennsylvania;* second quality, $35@$38.

MAGNESITE—Brick, per net ton, f.o.b. works: 9-in. straights, $65. Cement, $40, seaboard.

SILICA BRICK—Per M., *Pennsylvania* and *Ohio*, $43; *Alabama*, $51; *Illinois*, $52.

ZIRKITE—Per lb.; Powdered, 65@70 per cent ZrO_2, 3½c. Brick, straights, 80c.@$1 each.

[1]Price furnished by Foote Mineral Co., Philadelphia.

Metal Statistics

Monthly Average Prices of Metals

Silver

	New York		London Spot		Sterling Exchange	
	1928	1929	1928	1929	1928	1929
January	57.135	57.019	26.313	26.257	487.098	484.577
February	57.016	56.210	26.205	25.904	487.008	484.787
March	57.245	56.346	26.329	26.000	487.558	484.776
April	57.395	55.668	26.409	25.738	487.785	484.808
May	60.298	54.125	27.654	25.084	487.685	484.599
June	60.019	52.415	27.459	24.258	487.565	484.330
July	59.215	.....	27.262	.....	485.923	.....
August	58.880	.....	27.096	.....	484.979	.....
September	57.536	.....	26.440	.....	484.654	.....
October	58.087	.....	26.727	.....	484.584	.....
November	57.953	.....	26.704	.....	484.492	.....
December	57.335	.....	26.349	.....	484.690	.....
Year	58.176	.....	26.746	.....	486.169	.....

New York quotations, cents per ounce troy, 999 fine. London, pence per ounce, sterling silver, 925 fine.

Copper

	New York		London Spot			
	Electrolytic		Standard		Electrolytic	
	1928	1929	1928	1929	1928	1929
January	13.854	16.603	61.912	75.551	66.575	78.602
February	13.823	17.727	61.670	78.228	66.381	83.538
March	13.845	21.257	61.148	89.153	66.443	98.356
April	13.986	19.500	61.678	81.036	66.500	89.405
May	14.203	17.775	62.554	75.026	67.216	83.727
June	14.527	17.775	63.664	74.338	68.738	84.015
July	14.527	.....	62.881	.....	68.670	.....
August	14.526	.....	62.472	.....	68.750	.....
September	14.724	.....	63.522	.....	69.800	.....
October	15.202	.....	65.524	.....	71.935	.....
November	15.778	.....	68.080	.....	74.750	.....
December	15.844	.....	69.336	.....	75.000	.....
Year	14.570	.....	63.703	.....	69.230	.....

New York quotations, cents per pound London, pounds sterling per long ton.

Lead

	New York		St. Louis		London			
	1928	1929	1928	1929	1928 Spot	1928 3 Mos.	1929 Spot	1929 3 Mos.
January	6.500	6.650	6.280	6.498	21.773	22.213	22.111	22.344
February	6.325	6.853	6.069	6.739	20.283	20.747	23.128	23.156
March	6.000	7.450	5.805	7.348	19.938	20.352	25.409	25.591
April	6.100	7.187	5.991	7.025	20.306	20.563	24.783	24.408
May	6.123	7.000	6.012	6.761	20.483	20.813	23.949	23.750
June	6.300	7.000	6.152	6.790	20.985	21.211	23.694	23.603
July	6.220	.....	6.038	.....	20.602	20.957	.....	.....
August	6.248	.....	6.056	.....	21.634	21.628	.....	.....
September	6.450	.....	6.286	.....	22.050	21.769	.....	.....
October	6.500	.....	6.318	.....	22.082	21.796	.....	.....
November	6.389	.....	6.222	.....	21.239	21.469	.....	.....
December	6.495	.....	6.343	.....	21.342	21.730	.....	.....
Year	6.305	.....	6.131	.....	21.060	21.271	.....	.....

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Tin

	New York		London	
	1928	1929	1928	1929
	Straits		Spot	
January	55.650	49.139	253.222	222.727
February	52.440	49.347	233.833	223.138
March	52.220	48.870	232.722	220.781
April	52.270	45.858	234.204	206.887
May	51.582	43.904	230.886	197.545
June	47.938	44.240	217.280	200.206
July	47.040	.....	212.449	.....
August	48.012	.....	212.847	.....
September	48.073	.....	215.663	.....
October	48.966	.....	222.005	.....
November	50.750	.....	232.875	.....
December	50.185	.....	227.586	.....
Year	50.427	.....	227.131	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Zinc

	St. Louis		London			
	1928	1929	1928 Spot	1928 3 Mos.	1929 Spot	1929 3 Mos.
January	5.643	6.350	26.125	26.051	26.196	26.233
February	5.551	6.350	25.518	25.506	26.247	26.347
March	5.624	6.463	25.082	24.960	27.050	27.294
April	5.759	6.658	25.493	25.316	26.759	26.613
May	6.026	6.618	26.102	25.756	26.727	26.619
June	6.158	6.686	25.664	25.429	26.216	25.984
July	6.201	.....	24.946	24.972	.....	.....
August	6.249	.....	24.540	24.713	.....	.....
September	6.250	.....	24.497	24.625	.....	.....
October	6.250	.....	24.030	24.296	.....	.....
November	6.263	.....	24.801	24.827	.....	.....
December	6.349	.....	26.609	26.615	.....	.....
Year	6.027	.....	25.284	25.256	.....	.....

St. Louis quotations, cents per pound. London pounds sterling per long ton.

Antimony, Quicksilver and Platinum

	Antimony (a)		Quicksilver (b)		Platinum (c)			
					Refined		Crude	
	New York		New York		New York			
	1928	1929	1928	1929	1928	1929	1928	1929
Jan.	10.863	9.558	123.620	119.481	79.280	70.000	69.280	60.000
Feb.	10.842	9.548	121.370	119.818	84.783	70.000	74.783	60.000
March	10.083	9.531	122.557	121.904	80.000	70.000	70.000	60.000
April	9.865	9.462	123.740	122.000	80.000	70.000	70.000	60.000
May	11.019	8.957	123.173	121.154	78.000	68.615	68.000	58.615
June	9.750	8.845	122.423	120.500	78.000	68.000	68.000	58.000
July	9.540	.....	121.260	.....	78.000	.....	68.000	.....
Aug.	10.181	.....	124.500	.....	78.000	.....	68.000	.....
Sept.	10.813	.....	128.000	.....	78.000	.....	68.000	.....
Oct.	10.841	.....	125.923	.....	78.000	.....	68.000	.....
Nov.	10.109	.....	123.000	.....	76.417	.....	66.418	.....
Dec.	9.748	.....	122.500	.....	74.480	.....	64.480	.....
Year.	10.305	.....	123.506	.....	78.580	.....	68.580	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce.

Pig Iron[1] and Aluminum

	Bessemer		Basic		No. 2 Foundry		Aluminum	
	1928	1929	1928	1929	1928	1929	1928	1929
Jan.	17.50	18.00	17.00	17.50	17.25	17.50	24.300	24.300
Feb.	17.50	18.00	17.00	17.50	17.25	17.50	24.300	24.300
March	17.50	18.19	17.00	17.62	17.25	17.69	24.300	24.300
April	17.50	18.50	17.00	18.00	17.25	18.00	24.300	24.300
May	17.37	18.81	16.38	18.31	17.24	18.31	24.300	24.300
June	17.00	19.00	15.56	18.50	16.79	18.50	24.300	24.300
July	17.00	.....	15.75	.....	16.69	.....	24.300	.....
Aug.	17.00	.....	15.75	.....	16.50	.....	24.300	.....
Sept.	17.00	.....	15.75	.....	16.50	.....	24.300	.....
Oct.	17.24	.....	16.66	.....	16.74	.....	24.300	.....
Nov.	17.82	.....	17.32	.....	17.32	.....	24.300	.....
Dec.	18.00	.....	17.50	.....	17.50	.....	24.300	.....
Year.	17.37	.....	16.56	.....	17.02	.....	24.300	.....

Iron in dollars per long ton. Aluminum in cents per pound, 99 per cent grade.

[1]F.o.b. Mahoning and Shenango valley furnaces; freight to Pittsburgh, $1.76.

Monthly Crude Copper Output in Short Tons

Domestic

	1928		1929				
	Dec.	Total	Jan.	Feb.	Mar.	April	May
Alaska shipments	1,807	22,724	2,145	913	1,974	2,075	1,801
Calumet & Arizona	7,033	65,182	5,254	5,553	5,888	6,041	6,731
Magma	1,436	18,251	1,730	1,450	1,680	1,780	2,022
Miami	2,148	24,129	2,262	2,157	2,620	2,591	2,614
Nevada Con.	†40,613	134,231	.....	.....	†39,191	.....	.....
Old Dominion*	804	11,069	921	734	1,015	1,040	1,022
Phelps Dodge††	10,361	102,137	9,850	9,537	10,524	10,230	9,857
United Verde Extens.	2,344	22,073	2,338	2,024	2,504	2,682	2,732
Utah Copper	†42,956	136,920	.....	.....	†40,500	.....	.....
Tennessee Copper	558	6,792	597	616	635	619	676
Foreign							
Andes Copper	6,890	52,029	7,485	7,000	8,300	8,263	.....
Braden	4,740	109,137	6,510	4,830	9,375	9,265	.....
Boleo, Mexico	†3,422	12,782	.....	.....	†2,910	.....	.....
Bwana M'Kubwa	649	6,696	812	605	686	615	317
Chile	15,380	132,932	15,645	15,085	16,720	.....	.....
Furukawa, Japan	1,468	17,865	1,420	1,473	1,751	1,350	.....
Granby Cons., Canada	2,465	28,767	2,677	2,324	2,452	2,631	2,591
Howe Sound	†5,490	21,099	.....	.....	†5,157	.....	.....
Mt. Lyell	1,819	6,582	.....	.....	1,707	.....	.....
Sumitomo, Japan	1,660	17,898	1,502	1,335	1,680	1,657	.....
Union Miniere, Africa	9,440	123,880	9,753	9,477	11,820	12,810	13,224

†Three months. *Includes Arizona Commercial.
††Moctezuma is included.

Monthly Production of Primary Copper from U. S. Mines and Daily Rate (Short Tons)

	1927		1928		1929	
	Monthly Production	Daily Rate	Monthly Production	Daily Rate	Monthly Production	Daily Rate
January	76,198	2,458	68,469	2,209	86,325	2,785
February	69,202	2,472	67,423	2,352	84,735	3,026
March	69,314	2,236	70,327	2,269	93,698	3,023
April	71,122	2,371	69,721	2,324	94,902	3,163
May	71,613	2,310	73,729	2,378	93,026	3,001
June	69,539	2,318	73,224	2,441	.....	.....
July	65,545	2,114	73,426	2,369	.....	.....
August	67,248	2,169	76,952	2,482	.....	.....
September	65,936	2,198	78,341	2,611	.....	.....
October	68,545	2,225	86,480	2,790	.....	.....
November	68,080	2,269	85,382	2,846	.....	.....
December	67,377	2,173	85,673	2,764	.....	.....
Total	829,878	.....	909,147	.....	452,686	.....
Monthly average	69,165	.....	75,762	.....	90,537	.....
Average of daily rate	.....	2,274	.....	2,484	.....	2,998

Mining Stocks—Week Ended June 29, 1929

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda	New York	119¼	113¾	119	Jl. 13, Au. 19	Q 1.75
Andes Copper	New York	56⅜	51¼	54	Jl. 13, Au. 12	Q 0.75
Arizona Com.	Boston	3	3	3	Ja. 16, Ja. 31	S.A. 0.25
Calumet & Ariz.	New York	132	127	128½	My.31, Je.17	Q 2.50
Calumet & Hecla	Boston	44½	42	42½	My.31, Je.29	Q 1.00
Cerro de Pasco	New York	100⅜	97½	98¼	Ap.11, My. 1	Q 1.50
Chile Copper	New York	...	...	101	Je. 1, Je.28	Q 0.87½
Con. Coppermines	N. Y. Curb	12	11	11½	...	...
Copper Range	Boston	23½	21¼	22	Je. 15, Jl. 15	Q 0.50
East Butte	Boston	3½	3	3	Dec., 1919	0.50
Granby Con.	New York	79½	76¼	79¼	Jl.12, Au.1	Q 1.75
Greene Cananea	New York	170½	158⅜	170¼	Je. 6, Jl. 1	Q 2.00
Howe Sound	New York	68	65½	66	Je. 29, Jl. 15	Q 1.50
Hudson Bay	N. Y. Curb	17⅜	16½	17	...	...
Inspiration	New York	46½	44¼	45¾	Je.13, Jl. 1	Q 1.00
Isle Royale	Boston	22½	21	21	My. 31, Je.29	0.50
Kennecott	New York	87½	84¼	86¼	My. 31, Jl. 1	Q 1.25
Magma Copper	New York	69¼	67¼	67¾	Je.28, Jl.15	Q 1.25
Mason Valley	N. Y. Curb	1⅛	1⅛	1⅛	...	...
Miami Copper	New York	43½	41¾	43¼	My1, My15	Q 1.00
Mohawk	Boston	*30	*25	*25	Ap. 30, Je. 1	Q 1.50
Mother Lode	New York	3⅜	3⅜	3⅜	Je. 13, Je. 29	0.20
Nevada Con.	New York	48⅜	45¼	47	Je. 14, Je. 29	Q 0.75
Noranda	N. Y. Curb	59½	55	58⅛	...	...
Ohio Copper	N. Y. Curb	2	1⅛	1⅛	Sept., 1926	0.03
Old Dominion	Boston	10½	7½	9¼	Dec., 1918	1.00
Phelps Dodge	New York	62½	59⅜	60⅜	Je. 4, Jl. 1	Q 0.75
Quincy	Boston	39	36	36½	March, 1920	1.00
Roan Antelope	N. Y. Curb	48	46	46⅜	...	...
St. Mary's M. L.	Boston	38½	37	37	Fe.25, Mr.12	2.00
Seneca Copper	New York	5½	5¼	5¼	...	...
Shattuck Denn	N. Y. Curb	18	17	17⅜	...	...
Sherritt-Gordon	Toronto	8.00	7.30	7.70	...	...
Tenn. C. & C.	New York	18	17⅛	17⅛	My.31, Je.15	Q 0.25
United Verde Ex.	N. Y. Curb	18⅜	17½	17⅜	Jl. 2, Au. 1	Q 1.00
Utah Copper	New York	...	...	300	Je. 14, Je. 29	Q 4.00
Waite-Ack.-Mont.	Toronto	5.50	4.65	4.65	...	...
Walker Mining	Salt Lake	4.10	3.80	4.10	...	...
Wenden Copper	N. Y. Curb	1⅜	1¼	1¼	...	...
LEAD, ZINC, SILVER						
Ahumada Lead	New York	2⅛	2	2⅛	...	...
Amer. Z. L. & S.	New York	30	27	28	May, 1917	1.00
A. Z. L. & S., pfd.	New York	96⅛	95	95	Je.14, Jl. 1	1.50
Bingham Mines	Boston	...	...	56½	Mr.15, Ap.5	0.50
Bunker Hill & S.	N. Y. Curb	...	...	140	Ap.25, My.6	X 0.75
Butte Cop. & Zn.	New York	5⅛	4⅜	5	...	...
Butte Cop. Con.	Boston Curb	*31	*30	*31	...	...
Butte & Sup.	New York	7	6⅞	7	Je. 14, Je. 29	Q 0.50
Callahan Zn-Ld.	New York	1⅛	1⅛	1⅛	Dec., 1920	0.50
Chief Consol.	Salt Lake	2.20	2.05	2.20	Fe. 1, 1928	K 0.10
Consol. Ld. & Zn. "A"	St. Louis	14	13⅛	13⅛	Je.20, Jl.1	Q 0.25
Constitution	Spokane	*35	*32½	*35	...	...
Dayrock	Spokane	3.17	3.00	3.10	Je.20, Je.30	0.03
Dickens Consol.	Spokane	4⅜	4⅜	4⅜	...	...
Eagle-Picher	Cincinnati	17	16⅛	16⅛	Je. 30, Jl.15	Q 0.20
Eagle-Pich., pfd.	Cincinnati	...	...	102	Je. 30, Jl. 15	Q 1.50
Erupcion	Boston Curb	...	...	*10	Ja. 1, 1928	Q 0.07½
Eureka Bullion	Salt Lake	*33	*31	*33	...	...
Eureka Lilly	Salt Lake	...	...	1.42½	...	...
Eureka Standard	Salt Lake	...	...	3.32½	...	...
Evans-Wallower	N. Y. Curb	20⅜	19	19	...	...
Evans-Wal., pfd.	N. Y. Curb	...	...	84½	Je.20, Jl. 1	Q 1.75
Federal M. & S.	New York	240	240	240	Je., 1927	10.00
Fed. M. & S., pfd.	New York	100	100	100	My.24, Je.15	Q 1.75
Gladstone	Spokane	*9½	*8½	*9	...	...
Goleonda	Spokane	1.18	1.05	1.09	Je.15, Jl.1	0.02
Grandview	Spokane	*43½	*39	*42	...	...
Hecla Mining	N. Y. Curb	18	17⅜	17⅜	My.15, Je.15	Q 0.25
Highland-Surprise	Spokane	*14	*11	*11	...	...
Jack Waite	Spokane	*8⅜	*8¼	*8½	...	...
Kootenay Florence	Spokane	*14½	*14	*14½	...	...
Lucky Jim	Spokane	*12	*11	*11½	...	...
Lucky Tiger-C.	Kansas City	†4.25	†4.00	....	Je.10, Je. 20	M 0.05
Mexican Premier	Spokane	2.26	2.25	2.26	...	...
National Lead	New York	152⅛	151	151	Je. 14, Je. 29	Q 1.25
Natl. Lead, pfd. A	New York	140	140	140	Mr. 1, Mr. 15	Q 1.75
Natl. Lead, pfd. B	New York	118½	118	118	Jy. 19, Au 1	Q 1.50
N. J. Zinc, new	N. Y. Curb	79	78½	79	Jl.20, An.10	Q 0.50
New Quincy	Salt Lake	2.40	2.30	2.30	My.15, My.27	Q 0.10
Noble Five	Spokane	*65	*58	*58	...	...
North Lily	Salt Lake	7.40	7.25	7.40	Jan. 20	Q 0.25
Park Bingham	Salt Lake	8.00	7.50	8.00	...	...
Park Utah	New York	8	7	7⅛	Je. 14, Jl. 10	Q 0.20
Pend Oreille	Spokane	6.00	4.00	6.00	...	...
Rico Argentine	Salt Lake	*40	*38	*40	No. 30, De. 15	Q 0.03
Ruth-Hope	Spokane	*41	*30	*40	...	...
St. Joseph Lead	New York	69⅛	67	68	Se.10, Se.20	QX 0.75
Sherman Lead	Spokane	*37½	*35	*37½	...	...
Silver King Coa.	Salt Lake	...	...	12.50	Je. 20, Jl. 1	0.25
Silversmith	Spokane	*12	*11	*11	Oct., 1926	Q 0.02
Sunshine Mining	Spokane	3.03	2.97	2.98	Je. 10, Je. 20	Q 0.05
Tamarack-Custer	Spokane	*75	*70	*75	Sept., 1924	0.25
Tintic Standard	Salt Lake	13.50	13.25	13.25	Je. 17, Je. 29	QX 0.30
Tonopah Belmont	N. Y. Curb	....	....	*56½	Oct., 1925	0.05
Treadwell-Yukon	Toronto	10.00	9.75	9.75	...	...
United Zinc Smg.	N. Y. Curb	*68¾	*62½	*68¾	...	...
Utah Apex	Boston	3⅜	3⅜	3⅜	May 15, June 1	0.25
Utah Met. & Tun.	Boston	1.00	*97	1.00	Dec., 1917	0.30
Whitewater	Spokane	*90	*80	*85	...	...
Yellow Pine	Los Angeles	....	....	*8	Dec., 1925	QX 0.04
GOLD						
Alaska Juneau	New York	5⅛	5⅛	5⅛	...	...
Barry-Hollinger	Toronto	*29	*25	*28	...	...
Central Manitoba	Toronto	*47	*43	*43	...	...
Coniaurum	Toronto	...	...	*40	...	...
Cresson Consol.	N. Y. Curb	*68¾	*68¾	*68¾	Mr.30, Ap.10	Q 0.02
Dome Mines	New York	10	9⅛	9⅛	Jl. 20,	Q 0.25
Golden Cycle	Col. Springs	†1.95	†1.90	....	Fe.15, Mr. 1	0.04
Gold Hill	Toronto	*2⅛	*2	*2⅛	...	...
Hollinger	Toronto	5.70	5.55	5.65	Je.28, Jl. 15	FW 0.05
Homestake	New York	...	...	72½	My.20, My.25	M 0.50
Kirkland Lake	Toronto.	*87	*80	*86½	...	...
Lake Shore	Toronto	26.50	25.50	26.50	Je.1, Je.15	Q 0.20
McIntyre-Porc.	New York	16	15⅛	15⅛	My.1, Je.1	Q 0.25
Portland	Colo.Springs	†*11	†*10	....	April, 1927	0.02
Rand Mines	New York	...	...	35	Fe. 21,'28	Am.Sh. 1.52
Siscoe	Toronto	*65	*60	*63	...	...
Sylvanite	Toronto	1.20	*98	1.00	...	...
Teck-Hughes	Toronto	8.75	8.25	8.75	Jl. 18	Au. 1 0.15
Tom Reed	Los Angeles	*60	*41	*60	Dec., 1926	0.02
Unity Gold	N. Y. Curb	1	1	1	...	...
Vipond Consol.	Toronto	*91	*89	*88	April, 1927	0.03
Wright-Hargreaves	Toronto	1.74	1.64	1.71	Oc. 16, No. 1	0.02½
Yukon-Alaska	N. Y. Curb	....	....	35¾	...	...
GOLD AND SILVER						
Carnegie Metals	N. Y. Curb	21⅛	16⅛	19	...	...
Castle-Trethewey	Toronto	*32	*32	*32	...	...
Consol. Cortez	N. Y. Curb	...	...	*12½	...	...
Dolores Esperanza	N. Y. Curb	78	78	78	July, 1923	0.05
Keeley	Toronto	*46	*45	*45	Mr.15, 1928	0.04
Mining Corp.	Toronto	4.25	4.10	4.15	My 30, Je.13	0.12½
Montana-Idaho	Spokane	*12¼	*10½	*10½	...	...
N. Y. & Hond. Ros.	N. Y. Curb	...	...	17¾	Ap.17, Ap.27	QX 0.05
Nipissing	N. Y. Curb	2⅛	2⅛	2⅛	Je.29, Jl.20	Q 0.07½
Premier Gold	N. Y. Curb	1⅛	1⅛	1⅛	Je.13, Jl.3	Q 0.06
Tonopah Exten.	N. Y. Curb	...	...	*10	April, 1925	0.05
Tonopah Mining	N. Y. Curb	3⅛	3⅛	3⅛	Ap. 7, Ap. 20	0.07½
United Eastern	N. Y. Curb	*31¼	*25	*25	...	...
Yukon Gold	N. Y. Curb	*62½	*62½	*62½	June, 1918	0.02
IRON AND STEEL						
Bethlehem Steel	New York	112½	105	111½	Jl. 19, Au. 15	Q 1.00
Beth. Steel, pfd, 7%.	New York	119½	118	118	Je.1, Jl.1	Q 1.75
Cleveland-Cliffs	Cleveland	130	100	125	Je. 6, Je. 15	5.00
Colo. Fuel & Iron	New York	65½	62½	63	...	...
Colo. F. & I., 1st pfd.	New York	...	...	78	My.10, My.25	Q 2.00
Great Northern Iron.	New York	30⅛	28⅛	29	Dec.15,	K 2.00
Inland Steel	New York	92½	90	90½	My.15, Jn. 1,	Q 0.87½
Republic I. & S.	New York	101¼	94½	100½	My. 11, Je. 1,	Q 1.00
Republic I. & S., pfd.	New York	109½	109½	109½	Je .12, Jl. 1,	Q 1.75
Sloss-Sheffield S. & I.	New York	60	58½	60	Mr. 11, Mr. 20,	Q 1.50
Sloss-Sheff. S. & I., pfd.	New York	86⅞	86⅛	86⅛	Je.20, Jl.1,	Q 1.75
U. S. Steel	New York	191⅛	179⅛	190⅛	...	...
U. S. Steel, pfd.	New York	140½	140	140	My. 4, My 29,	Q 1.75
Virginia I. C. & C.	New York	....	....	25½	Jan., 1924	1.50
Virginia I.C.& C., pfd.	New York	....	....	45	Jl.16, 1928	SA 2.50
MISCELLANEOUS						
Aluminum Co. of Am.	N. Y. Curb	289¼	285½	285½	...	...
Alum.Co.of Amer., pf.	N. Y. Curb	106½	105	105	Mr.15, Ap.1,	Q 1.50
American Metal	New York	64½	59¾	64	Au. 21, Se. 1	Q 0.75
Amer. Metal, pfd., 6%	New York	120	115¼	120	Au. 21, Se. 3	Q 1.50
Amer. Sm. & Ref.	New York	110½	106	109¾	Je. 30, Jl. 12	Q 1.00
Amer. & Sm. Ref., pfd.	New York	133½	133	133½	Au. 3, Se. 1	Q 1.75
Ang. Ch. Nitrate	N. Y. Curb	41⅛	39	39¾	...	...
Asbestos Corp.	Montreal	10½	10	10¼	Jan. 1926	1.50
Asbestos Corp., pfd.	Montreal	31½	30	31¼	De. 31, Ja. 15	Q 1.75
Consol. M. & S.	Montreal	400	395	398	Je.29, Jl.15,	SAX 6.25
De Beers Consol.	New York	....	....	23	Ja. 19, Ja. 26,	0.48
Federated Metals	N. Y. Curb	35	33½	35	Je.25, Jl.5	Q 0.75
Freeport Texas	New York	48	45½	47¾	Jl. 5, Au. 1	Q 1.00
Int. Nickel Can.	New York	53½	50¼	51¼	Je.1, Je.29	Q 0.20
Int. Nickel, pfd.	New York	121	121	121	Jl.1, Au.1	Q 1.75
Mayflower Assoc.	N. Y. Curb	73	71	72¼	...	...
Metal & Mining	N. Y. Curb	22⅜	20⅛	20⅛	Je.20, Jl.1	Q 0.30
Newmont	N. Y. Curb	200	195½	198½	Je.29, Jl.15	Q 1.00
Patiño M. & E.	New York	38	35½	35¾	My. 31, Jn. 28	4a
So. America G. & P.	N. Y. Curb	2⅜	2¼	2¼	...	...
Texas Gulf Sulphur	New York	73½	69¾	70	Je.1, Je.15	Q 1.00
U. S. Sm. R. & M.	New York	61¼	57⅛	60	Jl. 5, Jl. 15	Q 0.87½
U. S. Sm. R. & M., pfd.	New York	53⅜	53⅛	53⅛	Jl. 5, Jl. 15	Q 0.87½
Vanadium Corp.	New York	92½	84	89⅛	Fe.1, Fe. 15	Q 0.75

Toronto Standard Stock Exchange, Toronto, courtesy Arthur E. Moysey & Co.; Salt Lake Stock Exchange, courtesy J. A. Hogle & Co. and Logan & Bryan, New York; Standard Stock Exchange, Spokane, courtesy Pohlman Investment Company.

*Cents per share. †Bid or asked. Q, Quarterly. A. Annually. SA, Semi-annually. M, Monthly. BM, Bimonthly. FW, Four weeks. K, Irregular. I, Initial. R, Resumption. X, Extra. The first date given is that of the closing of the books: the second that of the payment of the dividend.

LONDON QUOTATIONS—WEEK ENDED June 1, 1929

	High	Low	Last	Date	Amount
Alaska Mexican ($5)	20/—	20/—	20/—	...	...
Alaska Treadwell (25)	60/—	60/—	60/—	Nov., 1926	4 p.c.(d)
Aramayo Mines (25 frs.)	60/4½	58/3	60/—	May 1929	5 p.c.(†)
Burma Corp (10 rupees)	19/7½	18/10½	19/3	July 1929	9 annas*
Bwana M'Kubwa (5s)	22/3	19/9	29/6	...	...
Camp Bird (2s)	2/7½	2/3	2/6	April, 1928	16¾ p.c.
El Oro (£1)	5/—	4/9	5/—	Nov., 1924	2½ p.c.*
Frontino & Bolivia (£)	8/7½	8/7½	8/7½	Jan., 1929	3¾ p.c.
Mexican Corpn. (£1)	16/—	15/3	15/3	...	...
Mexico Mines of El Oro (£1)	8/6	7/6	7/6	Dec., 1926	3¾ p.c.*
Mount Isa (£)	44/4½	42/6	43/1½	...	...
N'Changa Copper Mining. (£1)	90/—	77/6	77/6	...	...
Oroville Dredging (4s)	1/10½	1/6	1/9	Nov., 1928	31½ p.c
Rhodesian Congo Border (£1)	210/—	182/6	185/—	...	...
St. John del Rey (£1)	17/6	17/—	17/3	Apr., 1929	7½ p.c.
San Francisco Mines (10s)	37/6	36/6	37/6	June 1929	15 p.c.
Santa Gertrudis (£1)	11/—	10/1½	11/—	July 1929	7½ p.c.
Selukwe (2s. 6d.)	5/9	5/1½	5/3	April, 1917	6¼ p.c.
S. Amer. Copper (2s.)	3/3	2/6½	3/—	Nov. 1917	75 p.c.
Tanganyika (£1)	61/10½	59/—	60/—	July, 1928	5 p.c.
Union Miniere du Haut-Katanga (Brussels)	11,325	11,010	11,010	April, 1929	300.00 fr

*Free of British income tax. †Swiss francs and plus 15 p. c. bonus. ‡Belgian francsand free of taxation. (d) U. S. Dollars